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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

Institute of British Foundrymen.

DECEMBER 3.

East Midlands Branch (Lincolnshire Section):—Ordinary meeting. "Cylinders for Steam and Diesel Engines," Paper by F. J. Cook.

Scottish Branch:—Ordinary meeting. "Rotary Furnaces in the Modern Foundry," Paper by W. Scott.

Wales and Monmouth Branch:—Ordinary meeting at Cardiff. "The Rotary Pulverised-Fuel Furnace for Cast Iron," Paper by P. M. Macnair, Ph.D.

DECEMBER 7.

Lancashire Branch (Preston Section):—Ordinary meeting. "Wages: Their Relation to Selling-Prices," Paper by W. A. Hodson.

DECEMBER 8.

Birmingham and Coventry and West Midlands Branch:—Ordinary meeting. "Some Experiences with the Balanced-Blast Cupola," Paper by H. H. Shepherd.

London Branch:—Joint meeting. "Some Aspects on the Selection of Engineering Materials," Paper by L. B. Hunt, M.Sc.

DECEMBER 9.

Middlesbrough Branch:—Ordinary meeting. "A Few Experiences in Practical Foundry Work," Paper by J. J. McClelland.

DECEMBER 10.

East Midlands Branch:—Ordinary meeting at Derby. "High-Duty Cast Iron," Paper by A. L. Norbury, D.Sc.

Coke Again.

The figures for the 1930 census of production have been issued for metallurgical coke and by-products. They show that the quantity of coke made in 1930 just exceeded 11½ million tons, valued at slightly over £9,500,000. The corresponding figures in 1924 were 12¾ million tons, valued at £16,750,000. By one of those curious accidents of statistical records this coke is described as foundry coke, but there is little doubt that it consists in the main of blast-furnace coke, and includes metallurgical coke made for foundry purposes. The manufactured-fuel figures will not be of particular interest to our readers, these consisting in the main of coal briquettes.

The figures show that the average selling value of coke was 16.6 shillings per ton in 1930, and 26.3 shillings per ton in 1924, showing a very striking drop in price.

While dealing with statistics we learned with interest of some figures relating to German foundries during the Paris Foundry Congress. We understand that there are in Germany about 1,500 foundries employing 180,000 workmen. The annual production is said to be two million tons of finished castings, having a value in round figures at par of £40,000,000.

These figures offer an interesting comparison with estimates which have been given in our recent issue for the tonnage output and value of the products of British foundries. In fact there is a striking similarity between both the tonnage output and the value for the two countries. There is, however, a very important difference; it is suggested in the information available that 75 per cent. of the German output is used in the construction of machines, that is, in engineering practice generally. We very much doubt whether the proportion is as high in this country, where the tonnage of cast-iron pipe, for example, probably bears a much larger proportion to the total tonnage.

One fact which emerges from the comparison is, assuming that the tonnage output and value of German foundries are approximately equal to those of the foundries in Great Britain, it is evident that the average German foundry is rather larger than the average British foundry since the output is distributed in Germany through 1,500 foundries, whereas the figure in this country is well over 2,000.

Desulphurisation—ET CETERA.

For the first time since its initial publication in 1902, THE FOUNDRY TRADE JOURNAL has deemed it expedient on technical grounds to publish a coloured supplement. Its object is to indicate to founders that whilst lowered sulphur content in cast iron has its uses, distribution is a still more important factor. These illustrations relating to Mr. Evans' Paper, to be read this afternoon, partially explain the import of the heading we have used for this article. In modern research work, of which the Paper under discussion is typical, the investigators are no longer content to accept such a platitude as "low sulphur is beneficial." Nor do they follow the lead of the manufacturers of proprietary articles by enunciating a list of ancillary benefits to be derived. Mr. Evans has given proof of a general amelioration of physical as well as chemical properties in grey and malleable cast iron and in steel, such as cleaner metal, better graphite formation, improved mechanical properties, and what to our mind is the most striking of all, sounder metal. Two illustrations are given of this; one, the more important, being a pair of small centrally-sectioned ingots cast from metal melted in a high-frequency furnace. The metal treated with soda ash is sound throughout its length, whilst the untreated metal is unsound in the central portion, which would, if cast in high-carbon steel, have been a "pipe." It is not clear from the Paper whether or not this is but a snatch test or one that can be repeated. Sufficient indication, however, has been given to enable each individual foundry to repeat the test themselves. Though perhaps a little premature, we wish to issue a word of warning. This soda process, the extended use of rotary pulverised-fuel, electric and oil-fired furnaces, together related and equally important developments in heavy metallurgy, all bring about the increased use of scrap and decreased employment of pig-iron. We can well envisage the time when, under flourishing trade conditions, scrap will cost as much or more money than pig-iron! A better peg upon which to hang one's hat is the making of good material better. Whilst apparently soda ash is easy of application, we state with-

out fear of contradiction that the best results will only be obtained where a proper metallurgical control is instituted. The hint thrown out by Mr. Evans as to an action comparable with that used when making Alpax and the like will, and can be, exploited only by those foundries possessing the means to exercise real metallurgical control. Truly, so far as soda ash is concerned, the et ceteras are more important than mere desulphurisation. Indeed, we think it might be advisable at this early stage definitely to dispel this restricted notion concerning soda ash and create something, maybe even a slogan, which more accurately represents the so-far-known functions of this reagent.

Sheffield Foundry Trades Technical Society.

Seventeen candidates who are members of the Sheffield Foundry Trades Technical Society, which is organised under the auspices of Sheffield University, entered for the recent examinations in foundry practice and patternmaking, conducted by the City and Guilds of London Institute.

The proportion of successes was very high, no less than twelve candidates gaining certificates. Additionally, the bronze medals awarded in foundry practice and science, and in the intermediate patternmaking, to the candidates obtaining the highest marks in the whole country, were won by members of the Society. The examinations are held in conjunction with the Institute of British Foundrymen, and the certificates to successful candidates were endorsed by Mr. Victor Stobie, President of the Institute.

The formal presentation of the medals and certificates took place in the Mappin Hall, University of Sheffield, on November 28, 1932. Mr. W. T. Kitching, President of the Society, presided, and expressed the gratification that he and the whole of the members of the Society felt at the high percentage of awards that had been gained by their members, most of whom were practical men with considerable experience, and who had had little opportunity of furthering their technical education, except by the opportunities provided by the Society. He also congratulated Dr. Longmuir and the other teachers who had prepared the candidates on the success of their work.

Prof. J. H. Andrew, Professor of Metallurgy in the University of Sheffield, then presented the bronze medals and certificates to the following successful candidates:—

Foundry Practice and Science.—Bronze medal for first place in the examination and first-class pass: T. R. Walker. First-class certificates: J. G. Rees, D. C. G. Bardsley and C. J. Dadswell. Second-class certificates: G. Gleadhall, C. D. Davy, E. Wrightam, J. Richardson, H. G. Lang, C. E. Morrish and R. H. Bowen.

Patternmaking—Intermediate Examination.—Bronze medal for first place in the examination and first-class pass: J. G. Rees.

Mr. T. Makemson, secretary of the Institute of British Foundrymen and hon. secretary of the City and Guilds Advisory Committee on Foundry Practice, conveyed to the successful candidates the congratulations of those two bodies upon their success, and expressed the hope that the unsuccessful candidates would enter for the examination in 1933. He then proposed a vote of thanks to Prof. Andrew for his interest. Prof. Andrew had come to Sheffield with a great reputation behind him, and it was evident that he was already going to increase that reputation, and he would enhance the prestige of the Metallurgy Department of the University.

Mr. C. D. Pollard, President of the Sheffield Branch of the Institute of British Foundrymen, seconded the vote of thanks to Prof. Andrew, and as an ex-President of the Sheffield Foundry Trades Technical Society, expressed his gratification that so many candidates had entered for the examination, and that the proportion of successes had been so high. He was particularly pleased that the winner of the bronze medal in foundry practice was Mr. T. R. Walker, who was the secretary of the Sheffield Branch of the Institute of British Foundrymen, and with whom he had close contact, and for whose abilities he had the greatest respect.

Prof. Andrew, in reply, said he was particularly pleased when he came to Sheffield to find the various trade technical societies in such a healthy condition. The University authorities were prepared to extend the facilities for the foundry trade, and already had in hand the preparation of a new foundry with suitable apparatus. He also paid a tribute to the enthusiasm of Dr. Skerl and all the other teachers of the various classes.

A congratulatory message was received from Mr. Victor Stobie, President of the Institute of British Foundrymen, who expressed his regret at not being able to be present at the meeting.

The ordinary meeting of the Society then followed the presentation, when a lecture on "Hardening and Tempering of Cast Iron" was given by Mr. J. E. Hurst.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Malleable Reception Tests.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The suggestion made by Mr. J. V. Murray and published by you in the discussion on the report of Malleable Iron Sub-Committee, appears to be a little ambiguous. On the face of it, it appears that we should be dismayed at the prospect of the inclusion of an impact test upon malleable castings. Mr. Murray was speaking for the trade generally, and many proprietors do not understand anything at all about mechanical tests.

There is no difficulty in obtaining a yield point, but an impact test means that another set of bars will have to be cast. This will make three sets of test-bars for the specification and would impose an added burden upon malleable ironfounders. It also means three testing machines if the hardness test be also included. As far as our own foundry is concerned we can undertake any tests, and castings that are made, and upon which depends the safety of lives, the test cannot be made too high. This was one reason why the yield point was suggested, and also the impact test. It is quite possible to obtain a yield point as low as 40 tons and as high as 95 tons per sq. in. in well-annealed malleable castings. White-heart malleable cast iron is but faintly understood in many quarters, and the researches that we are carrying on reveal new and distinctive features of which use may be made commercially. When malleable ironfounders make an intelligent use of the metallurgist, the white-heart section will enter upon a new era of prosperity.—Yours, etc.,

For the Murray Foundries, Limited,
JOHN V. MURRAY,
Director.

Caldmore, Walsall.
November 26, 1932.

MESSRS. YARROW & COMPANY, LIMITED, of Scotstoun, have received the order for three Yarrow water-tube boilers for the power station at the new steelworks at Pretoria of the South African Iron & Steel Industrial Corporation, Limited.

Random Shots.

Really, really! These outsize testing machines that "Marksman" has been reading of have made him quite uneasy. The other night he had a dream, peeped into the future. "Marksman" found himself in a little town in Kent, admiring one end of the latest machine for testing steel cable. He climbed into an aeroplane, flew northwards for ninety minutes, landed, and what do you think? There was the other end of the machine!

* * *

OVERHEARD.—I.

On the Foundry Floor.

VOICE THE FIRST: "Yes, I went to the dogs last night, an' had a bit of luck too. Finished up three-an'-six to the good. You ought to have seen Lazy Lucy in the last race—she was great! Thought she'd catch the hare an' all."

VOICE THE SECOND: "And what you going to do with all that money? You'll have the Bank of England round here asking for a loan if you go on like it."

VOICE THE FIRST: "I'm going on one of those winter cruises, of course. Spend the Christmas in Egypt, an' if it's not warm enough go on to India!"

VOICE THE SECOND: "Yes, and cut across to Hollywood and have tea with Constance Bennett, I don't think!"

VOICE THE FIRST: "That reminds me. What about this job for Bennett? The boss says it's urgent. But we can't do much now, can we? The hooter'll go in ten minutes."

VOICE THE SECOND: "Best leave it till the morning, hadn't we? We can't start on it now."

VOICE THE FIRST: "No, we can't start on it now. Best leave it till the morning."

* * *

"Marksman" has garnered a few new stories lately. Here they are.

"You have to work quickly here," said the foreman to the new hand. "Are you a fast worker?"

"Fast?" grunted the new hand. "Why, I'm so fast that I can switch off the light and be in bed before the room is dark!"

* * *

Another "fast" story, not quite so new, is of the young man who wrenched open the railway carriage door, tumbled inside and collapsed, gasping, as the train slid out of the station.

A colonel, in the opposite corner, grunted: "When I was your age," he said, "I could sprint down a platform and catch a train without turning a hair."

"But I—missed—this—at the—last station," panted the young man.

* * *

The job was "spinning out" unduly, and the manager buttonholed the foreman and asked the reason why. The foreman was apologetic. "If I move Heaven and earth, I can't get the job finished under a week."

"Well," said the manager, "try raising hell and finish in a couple of days."

* * *

Foreman (addressing lady who had been watching his moulders at work): "I hope you will excuse their language, madam. My men always call a spade a spade."

Lady: "Really! I thought I heard them call it a beautiful shovel!"

MARKSMAN.

THE GOVERNORS OF Loughborough College, Leicestershire, invite applications for the award of ten open scholarships in the Faculty of Engineering, each of the value of £75 per annum.

THE MEMBERS of the iron and steel trade delegation, the first of three British trade delegations which are to visit Scandinavian countries to confer with Danish, Swedish and Norwegian importers, are now in Copenhagen.

Some Methods of Production in a Modern Malleable Iron Foundry.*

By H. J. Beck, of Ley's, Derby.

This is not a scientific Paper in the strict sense of the word, but an informal discussion on the methods used in one of the largest, if not the actual largest black-heart malleable-iron foundry in Europe. The output of castings from this foundry during the last five years has been approximately 45,000 tons. Taking into consideration the class of casting produced gives some idea of its size, as the weight per piece varies from 0.03 lb. to 60 lbs., over 60 lbs. being an exception, whilst the average weight is approximately 1 lb., automobile, textile, electrical, agricultural and the general engineering trades all using large quantities of black-heart malleable castings.

Melting.

All metal is melted in nine air furnaces, five of which are of 5 to 6 tons capacity, and are hand-fired with hard coal, two or three heats per day being run off as required to clear the moulding floor. Four are of a later type, two of 10 to 15 tons capacity, and two 15 to 20 tons capacity melting one or two heats per day as required, all of which are fired by pulverised fuel.

Furnace Charges.

These are made up from 40 to 45 per cent. pig-iron and 45 to 50 per cent. sprue, the balance being adjusted by the addition of annealed scrap either bought or resulting from the annealed scrap from the plant and a small percentage of steel scrap to conform to an analysis of:—T.C., 2.4; Si, 0.95, and Mn, 0.36 per cent.

The composition and melting of all heats is controlled by the laboratory staff, the head of which is Mr. A. E. Peace, and no heat is tapped until it has been analysed and actually seen by him or his chief assistant. If the analysis is low in T.C., Mn or Si, additions are made to adjust the balance. To indicate the care and attention bestowed on the melting and testing on each individual charge before and after melting, one day's routine of one pulverised-fuel furnace, starting from cold, is detailed.

Sections of the roof were lifted and 20 tons of metal charged. Fuel was turned on at 12.30 a.m., and at 4.30 a.m. No. 1 plug removed and the furnaceman started to remove the slag and level down the charge. This was repeated at 30-min. intervals. At 7.30 a.m. laboratory test No. 1 was cast, shaken out, crushed and analysed, after which the procedure is indicated by the following time-table:—

7.45	1st fracture test cast.
7.55	1st fracture test put in to the depth of 2 in. in running water.
8.0	2nd fracture test cast.
8.5	1st fracture test broken, slightly mottled.
8.10	2nd fracture test water quenched.
8.10	Result of No. 1 test analysis received by telephone is stated to be T.C. 2.6, Si 1.0 and Mn 0.43 per cent.
8.15	3rd fracture test cast at 1,500 deg. C.
8.25	Heat tapped at two points.
8.40	Test cast, which, when analysed, showed T.C. 2.4, Si 0.95 and Mn 0.36 per cent.

The four latest and largest furnaces are fired by pulverised fuel, and under normal working conditions these furnaces produce a high-temperature metal at approximately 1,500 deg. C., with an average fuel ratio of 1 ton of coal to 2 to 3 of metal. Fine, hard, dry coal is essential, as is secondary air to be admitted at low pressure; the waste heat is utilised for heating the remainder of the works.

All British irons are used in the production of black-heart malleable castings, contrary to what was deemed possible some few years ago, when it was considered necessary to use large quantities of American and other irons.

Machine Moulding.

Over 80 per cent. of the output is machine moulded on a piece-work basis, on five distinct types of machine. The oldest type used is the "Farwell," or hand press; this is a simple saddle top, with hand lever and balance weight used for light or intricate joint line, or short order work which would be too expensive to mount on pattern plates. For this type of machine the runners and feeders are attached to the pattern in brass or aluminium. The moulds are made in snap flasks from an odd-side made in ground red sand, doped with waterglass or silicate of soda and occasionally in plaster of paris.

Air Squeeze Machine.—This machine is worked by compressed air at 100 lbs. per sq. in. pressure. Cylinder bore is 8 in., the stroke 6 in., and the lifting capacity approximately 2,000 lbs. One squeeze is generally sufficient for one mould, as the cope and drag are pressed at one operation. The machine is fitted with a vibrator for withdrawing the pattern, and a blow valve is attached for cleaning the pattern.

Squeeze Jolt Machine.—A combination of the jar-ram and air-squeeze machine working at 100 lbs. per sq. in. pressure, strongly built to withstand hard wear, is used for a heavier class of casting than the air squeeze, being bolted on to two channel irons, 6 in. by 3 in., cast in a concrete block 24 in. by 24 in. by 24 in., the jolt table and press being of malleable iron. The lifting capacity of these machines is 250 lbs. when operating with a 3½-in. jarring piston having a 2½-in. stroke.

On the 8-in. squeezing piston the lifting capacity is 2,000 lbs. They incorporate a swivel-pressing 20-in. by 16-in. head, whilst the inlet and exhaust ports and piston rings are so arranged that they are trouble-free and almost foolproof.

Quite a number of these machines have been in work for nearly three years, and all they have required is a daily oiling. A knee-valve-operated vibrator and a blow-valve is fitted to each machine. When repairs are necessary, it is only about two hours' work to remove the damaged machine from channel irons and fit another one, as all are interchangeable. These machines are adaptable for either snap flasks or light steel boxes, carrying single- or twin-pattern plates to work singly or in pairs, according to the output required from any given pattern.

Jolt Ram.—This is the common jar-ram type, familiar to most foundrymen, but smaller, having a table top 24 in. by 16 in., and the machines are used in pairs. They carry a 4½-in. cylinder bore, 2¼-in. stroke, and have a lifting capacity of 1,500 lbs. Four to six jolts are usually sufficient for one-half mould. Boxes 22 in. by 22 in. by 7 in. deep are the maximum used on this machine. Foot valves for the vibrator and hand blow valve are fitted as standard.

Sandslingers.

These are the only machines in use in the foundry that are not made in the works. These machines are driven by electricity (400 volts), and are of the tractor type, and travel into the sand pile under their own power, collecting the sand from the floor by means of a left- and right-hand cutting screw conveyor, which turns the sand towards the centre of the machine; from there it is lifted by means of a bucket elevator and deposited on the screen of an oscillating riddle. The riddle is arranged and so constructed that scrap, chills, gaggers and bits of hard core, which may be in the sand, work down the shute into a scrap box which is mounted on the main arm. The riddled sand is deposited on the belt by the oscillating riddle, which delivers it into the impeller head. This discharges it with centrifugal force into the moulding box. The maximum ramming capacity is 10 cub. ft. per min., but this can be regulated by the speed. The machine is driven in to the depth of the sand pile. The impeller head has a radius of 9 ft., whilst the cutting conveyor is 11 ft. wide. It requires a bay 200 ft. long and 16 ft. wide for good practice.

Moulding.

The moulding of malleable castings is a fruitful source of knotty problems to the founder. Some of them are common to all classes of moulding, but the majority are not encountered by the founders of grey iron. Feeding, pouring, gating, etc., are very different from ordinary practice, and a casting which will present little or no difficulty in most foundries may become almost impractical for manufacture of a malleable casting. For this reason purchasers of malleable casting would be well advised, if they placed before the manufacturer the drawing or design for approval, before making the pattern for new work, as very often some slight change in section or design will lead to success in production.

There can be no hard and fast line for the production of satisfactory work, and only a general idea can be given; in fact the same feeder and runner is never put on two patterns unless a set of patterns is being duplicated. Sometimes a pattern is designed to answer the same as one already in production with the exception of perhaps the addition of four or five ounces of metal in the form of a projecting boss, which calls for a different method of feeding. For every new pattern that enters production, feeders and runners are tried out before fitting to pattern plates.

Primarily the founder has to produce the casting from materials that will satisfactorily anneal or his efforts will be useless. To achieve this it is necessary to pour the moulds with iron of a low-silicon content and in the case of black-heart material with a low T.C. content, both of which shorten the freezing range. Therefore, there must be a high degree of superheat in the metal as poured actually of the order of 1,500 to 1,600 deg. C. This high casting temperature, short freezing range, high liquid and solid contraction are a set of conditions which make the production of castings of uneven or thin sections anything but an easy proposition. But, in the face of this, good reliable and sound castings are made as will be acknowledged from the data shown of machinability to be submitted.

TABLE I.—*Showing Uniformity of Composition.*

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
T.C. ..	2.46	2.42	2.38	2.33	2.30	2.28	2.46	2.41	2.36	2.32	2.31
Si ..	0.938	0.938	0.938	0.938	0.938	0.938	0.906	0.906	0.896	0.890	0.890
Mn ..	0.309	0.305	0.299	0.296	0.286	0.253	0.326	0.317	0.302	0.299	0.299

Samples 1—6 were taken at 10-minute intervals from a 12-ton pulverised fuel-fired furnace and 7 to 11 from a 5-ton hand-fired charge.

* A Paper read before the Wales and Monmouth Branch of the Institute of British Foundrymen at Bristol, Mr. W. Williams presiding.

Obviously, to overcome these special conditions the founder cannot adopt grey-iron foundry practice of running a softer mixture for the light work owing to the fact that an iron that would give a white fracture in sections of $\frac{3}{8}$ in. thickness may show free carbon in sections of 1 in. or over. Table I shows the uniformity of composition attained from two different melts.

As all castings cannot be made of one section the practice is adopted where possible of pouring the light work early on in the heat. Generally speaking, moulds must be poured quickly as it is necessary to fill them with liquid metal so that there is the time and temperature for the heavier parts of the castings to secure the advantage of the necessary feeders and chills. It is desirable with heavier castings not to admit too much iron into the mould at one particular point as it may so heat up the mould locally as to cause a grey or heavy-mottled fracture where this has occurred; also, in a thin casting, too much metal admitted at one point will set up local heating of the mould and cause porosity. Slow pouring often causes short run and drawn castings. When trouble is found in running thin castings the fault may be in too close a a sand mixture and this can be remedied by the addition of sharp sand.

Moulds should be soft rammed, consistent with the size of the casting, whilst the sand must be as dry as possible, associated with the use of as little red sand as possible consistent with lifting bond. The latter, together with hard-rammed and wet moulds, is a prolific source of defective castings. With the use of superheated metal, trouble with slag inclusion is experienced and, as most of the work is cast with hand ladles, the ordinary skimming methods cannot be used. To overcome this trouble 95 per cent. of the castings (by weight) are poured through a perforated dry-sand core runner.

Common Defects.

Pulls, which are small fissures or cracks, often occur at changes of section, corners which have not enough fillet, on the outside of circular plates, also on flanges joined to a barrel-like casting which it is necessary to feed in the corner. These pulls must be avoided and are remedied by what malleable foundries term "ties." These are thin sections of metal added across the position on the casting where the pull shows. This thin piece of metal sets sooner than the adjacent part of the casting and so takes the contraction strain, the "tie" is easily removed from the casting in the hard state.

Cracks which may pass the hard-iron inspection are plainly revealed after annealing, opening up with the expansion of the metal. A difference is made between hot cracks or pulls and castings accidentally cracked in the hard state, from the appearance of the fracture, after annealing; the former having a rough or grained fracture and the latter a practically smooth face.

Feeding.

Feeding is a most important feature, and the proportion of feeders and runners to castings may range from 30 to 100 per cent. (by weight) according to the class of work and method of production. In the spray moulding of light castings, the spray must be strong enough to carry the patterns and withstand the rapping, and in this method the proportion of sprue to castings is always high.

Wherever possible, top feeding is avoided, as this is the source of dirty moulds and waste of metal, owing to the fact that the iron in the feeding is open to the atmosphere, causing it to set quickly, which can only be overcome by increasing the body of metal. The better plan is to fix the feeder on the joint of the mould; this involves no loss of pressure and ensures the feeder remaining liquid until the casting is set. Cylindrical castings with flanges are always better fed on the joint in the root where the flange meets the body. All feeders and runners are removed from castings in the hard state; very thin, fragile castings have feeders and runners knocked off as soon as they are set and placed in a reheating oven of about 500 deg. Fah. to prevent cracking. All castings are rumbled and sand-blasted before inspection.

Assembling of Moulds.—All metal-moulding boxes used in Ley's foundry are of the no-pin double-snug type. Pattern plates are fitted with a standard $\frac{3}{8}$-in. pin and all moulding boxes are jig-drilled to $\frac{7}{8}$ in., reamed out to $\frac{5}{1000}$-in. clearance and assembled with a pair of assembling pins at least 10 in. long. This does not leave much chance of cross-jointed work.

Cores.—Cores should be made friable consistent with strength to withstand handling, and in many cases must be made hollow so that they readily collapse and permit the casting true freedom for contraction. Various mixtures of oil sand and other sands are used—sea sand, red sand and floor sand, mixed wet or dry, liquid or dry bond. No less than 90 per cent. cores are made on a piecework basis, and 50 per cent. are baked in metal or shell carriers. All cores baked at 400 deg. Fah. by pulverised-fuel firing.

Annealing by Pulverised Fuel.

All castings are annealed in pulverised-fuel-fired stoves in white-iron pots with packing material to prevent undue distortion, consisting of air-furnace slag and other inert materials in equal proportion.

Annealing-Oven Capacity.—The capacity of the ovens are 25 tons of castings, 25 tons of pots and 16 to 17 tons packing material—that is, 66 to 67 tons per oven. The contents are gradually heated to 870 deg. C., which usually takes 50 to 60 hrs. and kept at that temperature for 50 to 60 hrs. (the ovens being pyrometrically controlled). Then the oven is gradually cooled to 630 deg. C. over a period of 120 hrs., and 24 hrs. after reaching 630 deg. C. the oven is opened and doors removed. The oven is emptied as soon as cool enough to handle. The castings are then rumbled again, the feeders and runners being ground off and fettled where necessary.

Annealing Temperature.—The only type of pyrometer in use is the recording thermo-couple; the couple is immersed in the annealing pot with the castings, otherwise it simply records the temperature of the oven atmosphere, and the pots lag behind this to such an extent as to make it impossible to say definitely when the castings are up to heat.

Straightening and Setting.

Black-heart malleable castings do distort during annealing, and, due to fine limits required by the machinists, have to be "set." Engineering and motor details are usually "set" in dies under a heavy press after being reheated to 600 or 700 deg. C.

Machinability of Black-heart.

The free-cutting properties and speeds of machining attained on black-heart malleable are shown by the figures of Table II. These were obtained from a well-known firm of machinists who manufacture 20 to 30 tons of motor-car components per week.

Table II.—*Data on Machining Speeds.*

Turning and facing a 10-in. dia. flange on a large casting.	*Roughing speed*—108 ft. per min. *Finishing speed*—182 ft. per min.
Turning and facing a cylindrical piece 6½ in. dia.	*Roughing speed*—140 ft. per min. *Finishing speed*—400 ft. per min.
Turning and screwing a light sleeve-casting.	*Rough turning*—100 ft. per min. *Finish turning*—235 ft. per min.
Screw-cutting with single point tool.	70 ft. per min.

The last-cited job is one of great accuracy, as the working limit allowed being plus or minus 0.0005 in. Precision in the diameter of the thread is secured by working to a dial indicator and hundreds of the pieces are produced without regrinding the tool. As regards uniform machinability and absence of hard spots, the record of machining 39,207 radiator ferrules 1¼ in. dia. screwed right- and left-hand threads without regrinding the dies is sufficient evidence.

Physical Properties.

The physical properties of black-heart malleable are set out in Table III.

Table III.—*Physical Properties of Black-heart Malleable using Tensile Bars 0.564 in. dia. and bend bars 1 in. × ⅜ in.*

Average of 100 consecutive heats.	Tensile 24.8 tons per sq. in. Elongation on 2 in. 19.9 per cent. 175 deg. bend.
Bar with highest tensile strength.	27 tons per sq. in. 19.0 per cent. elongation on 2 in. 180 deg. bend.
Bar with lowest tensile strength.	22.2 tons per sq. in. 19.0 per cent. elongation on 2 in. 180 deg. bend.
Bar with highest elongation.	24.88 tons per sq. in. Tensile strength. 27.0 per cent. elongation on 2 in. 180 deg. bend.
Bar with lowest elongation.	24.36 tons per sq. in. Tensile strength. Elongation 13.0 per cent. on 2 in. 160 deg. bend.

The above physical properties of black-heart malleable cited were obtained by Mr. A. E. Peace, Chief Metallurgist, to whom, in conjunction with Mr. W. T. Evans, Works Manager, the author is indebted for the facilities given for compiling this Paper.

Austrian Magnesite.

CONTROL OF PRODUCTION.

Of the total European output of magnesite about 70 per cent. is produced by two concerns in Austria, the Veitsch Magnesite Works and the Styrian Magnesite Works. Of the former company's 20,000 shares, 17,300 have been placed in a pool, of which 7,000 were until recently held by a French group (De Wendel-Schneider-Creuzot), another 7,000 are held by a German group (Dresdner Bank-Flick), and the remaining 3,300 were until recently held by the Austrian Credit Anstalt. So that the votes of the two groups, the French and German, were balanced, and the Austrian Credit Anstalt had the casting vote. There had been a kind of tacit understanding that none of the groups was to buy or sell shares in the pool without previous notice to the other two groups.

At a recent board meeting of the Veitsch Company it became known that the Credit Anstalt had sold its parcel of shares to the French group through its affiliated Swiss branch. The consequence of this deal is that the German group can be outvoted by the French group. It is alleged that the shares were sold by the Credit Anstalt without any previous notice, and hence the German group is protesting, and there is a talk of legal proceedings and claims for damages against the Austrian Credit Anstalt. Reports regarding claims for damages are, however, contradicted by the German group's legal representative in Vienna, Dr. Alfred Lederer.

American interests have assured their annual supply of 50,000 tons of Austrian magnesite through Trieste by the formation of the Austro-Americana Company of Radenthein, and negotiations are in progress to obtain for the British market similar conditions.

Electric Furnaces in America.—According to Dr. John A. Mathews, vice-president and director of research, Crucible Steel Company of America, New York, the first electric furnace put to practical use in steel-making in America was installed at Halcomb Steel Works, Syracuse, N.Y., in 1906. Its capacity was four tons. It was operated as a refining furnace, and was charged with molten metal from an adjacent open-hearth furnace. It had two carbon electrodes 14 in. sq. The cost of electrodes at one time averaged $8 a ton of steel melted, but within a few years the cost had been reduced to less than 50 cents a ton of steel melted. In 1909 there were not over a dozen steel-making electric furnaces in the United States; in 1932 there are more than 500, producing steel commercially, having capacities ranging from one-half ton to 100 tons.

Handling Materials in a Modern Foundry.

(*For illustrations see page* 336.)

Messrs. John Harper & Company, Limited, who have a world-wide reputation for the quality of their castings and also for design and lay-out of foundry equipment, as will be gathered from previous articles* published in the Journal, have recently made large extensions to their foundries at Willenhall. Together with these extensions they have installed plant which may well be considered as efficient as brains and ingenuity can devise, and, whilst in the cause of progress, change is constantly taking place, since setting the whole installation to work the results obtained have more than justified the expectations of those responsible for the conception of the scheme.

An item of the plant which is of special interest to foundry engineers is the overhead electrical-transporter system, the duty of which is the distribution of fresh sand to the moulding machines and the collection of used sand and scrap. Of these the former is returned to the automatic sand-conditioning plant and the latter to the position from which the cupola is charged.

A Mile and a-half of Track Work.

Essentially the scheme comprises one and a-half miles of transporter track, two 1-ton transporters each having its own transfer carriage, tracks for the carriages and all the electrical-conductor material. The plant was designed in collaboration with the company's engineers and the whole of the work entrusted to Messrs. S. H. Heywood & Company, Limited. Two tracks are provided in each of the 600-ft. bays. Along one is brought the fresh sand which feeds the moulding machines and after casting the used sand and scrap is deposited in a position under the other track, and thence removed direct to its natural destination. There are only two slight curves in the whole length.

In a position approximately at the centre of the building is a break in the fixed tracks and transversely across this break a crane of the single-girder type can travel in such a way that its main member forms a bridge between the two ends of the fixed track. The driver of each transporter has one of these carriages for his exclusive use, and this is mechanically and electrically interlocked with the fixed runway, so that he alone has full control. With the transporter on the carriage, stops are lowered which would prevent the framework fouling any stanchions and until the stops are in this position the bridge cannot be moved. In the up position the stops engage with the ends of the runways, and only when in this position can the transporter be moved. Thus it would not be possible for the transporter to fall over the end of the track because some other person had meanwhile removed the link. The speed of bridge travel is 350 ft. per min.

Transporter Details.

The transporters are of conventional design; the load being lifted at a speed of 60 ft. per min. on a four-part rope. Special attention has been given to accessibility and ease of maintenance. Steel is employed for all gears and runners and split-bearings are used in conjunction with shafts ground to size. The barrel and sheaves are of large diameter and machined with deep grooves to accommodate the rope.

An interesting feature is the arrangement of the travelling runners, each of which is equipped with a double taper-roller bearing and mounted on the Heywood patent axle, which enables any one to be dismantled in a few minutes without removing the side members of the framework or, indeed, any portion except the required runner and its axle. Side rollers which engage with the flange of the track obviate any possibility of chatter of the bogies. The full load speed of travel is 600 ft. per min. and a foot brake is provided to give rapid deceleration.

Self-righting and self-dumping buckets are used for carrying the sand and the trip wire to the catch is led on to a spring-controlled drum on the transporter. Application of the brake on this drum whilst lowering causes the bucket to dump its contents at any height.

The conductors carrying current at 230 volts continuous are of iron, of ample section, and dumb-bell shape. This type was adopted owing to its rigidity and the ease with which it can be supported and bent to suit curves. Against the underside of these revolve trolley wheels on spring arms.

By means of this installation with two operators, the whole of the very considerable quantity of moulding sand used in this busy foundry is brought to the most convenient position for its use. Power costs are negligible compared with work achieved and maintenance beyond routine greasing and inspection has cost nothing.

To the visitor to Messrs. John Harper & Company, Limited's foundry the speed with which this plant performs its onerous duty is but an outward and visible sign of that efficiency which permeates the whole organisation.

* Vol. 44, page 437, *et seq.* Vol. 45, page 163, *et seq.*

Basic-Bessemer Process.

CHANCES OF REVIVAL IN GREAT BRITAIN.

In the course of his Presidential address to the Cleveland Institution of Engineers at Middlesbrough recently, MR. WELDON HANSON remarked that the steel-making process in that district was entirely basic open-hearth, the basic-Bessemer process, which was a child of that district and had a long life, having been completely abandoned several years ago. As there was some talk of resuscitating the basic-Bessemer process in this country, one would naturally ask why it was abandoned. In his opinion one of the principal reasons was the craze for nothing but the highest quality of material in this country irrespective of the purpose for which it was intended. It was well known that basic-Bessemer steel could not compare with open-hearth steel in regularity and quality. Our engineers, therefore, simply debarred it in the majority of specifications, heedless of whether it was sufficiently good for the job in hand, even though it was not so good as open-hearth steel.

It was now being realised that basic-Bessemer steel is good enough for many purposes, and the fact had been brought home by the imposition of 33⅓ per cent. tariff on imported steel. Those who had hitherto bought this class of steel from the Continent now found that source of supply virtually closed to them and were crying out for its manufacture in this country. But why, it might be asked, were they to revert to basic-Bessemer steel when open-hearth steel would serve the same purpose? The reason given was that it cost less to make and was consequently cheaper than open-hearth steel. In the speaker's opinion, it was very doubtful whether the conditions here would ever permit of its being made cheaper than open-hearth steel. Yield in all manufacturing processes was a very important item affecting the cost, and it was in this respect that the Bessemer process got a bad fall, being about 15 per cent. below that of open-hearth. The basic-Bessemer process also required a special iron which was more costly to make than the open-hearth iron, and cheap scrap could not be so freely used. On the other hand, there were compensations in the way of a richer and more saleable slag.

ORDERS HAVE BEEN BOOKED at the Victoria Works, Sheffield, of the English Steel Corporation, Limited, of a value between £80,000 and £90,000 for high-pressure boiler drums for large electric power plants.

Oxygen in Iron.

In a communication from the Research Laboratory of the United Steelworks Company, Dortmund, published in a recent issue of "Archiv für das Eisenhüttenwesen," RESCHKA, SCHEIL and SCHULZ reported the results of an investigation on the solubility of oxygen and the effects of the presence of iron and other oxides. In most cases "ferrum reductum" was employed as the starting point, containing 0.07 per cent. C, traces of Si, 0.03 per cent. Mn, 0.01 per cent. P, 0.017 per cent. S and 3 per cent. O_2, instead of commercial steels as in other investigations, in order to isolate the effects of the different oxides. The oxygen was as a rule reduced by purified hydrogen giving a powder containing 0.2 per cent. O_2, the desired content of oxygen being obtained by adding iron oxide prepared from the same iron. Other tests were made by the addition of MnO_2, Al_2O_3, SiO_2, CaO, MgO, $FePO_4$, FeS and MnS in commercial forms.

Small test-pieces were formed as pressed cakes which were sintered in a current of purified hydrogen at temperatures between 800 deg. and 1,300 deg. C., the porosity being still about 20 per cent. With up to 3 per cent. O_2 as iron oxide or 2 per cent. O_2 in the form of the other oxides the cakes could be further compressed by forging at temperatures between about 1,200 deg. and 1,300 deg. C. After this treatment they appeared metallic, the surface being indistinguishable from that of mild steel on removal of the scale.

From determinations of the specific volume and the electrical resistance, as also from microscopic examination and tempering tests, it was concluded that the solubility of oxygen in α iron is very low, less than 0.08 per cent. at room temperature. The increase of solubility with rise of temperature is also very slight; at quenching temperatures of 1,300 deg. C. the upper limit is given as about 0.04 per cent., the actual amount being probably very much less.

The tensile strength increased at first with the oxygen content up to 0.2 per cent. and then slowly decreased. The ductility decreased with increasing oxygen content, but was still higher than that of cast iron with 3 per cent. O_2.

The forgeability was not reduced by oxygen alone to the extent that might have been expected from previous publications. Additions of high-melting-point oxides, such as CaO, SiO_2, Al_2O_3 and MgO, decrease the forgeability much more than does iron oxide (Fe_3O_4). The reduction of forgeability by FeS is due to the enveloping of the iron grains in the sulphide melt, which is liquid at forging temperatures. Additions of MnS, which as well as $FePO_4$ flows together into drops, do not cause a similar reduction in the hot plasticity.

Heat-Treatment of Steel by Gas.—Speaking at the 21st annual general conference of the British Commercial Gas Association at Leeds, Dr. H. V. Fell, chief of the Fuel Research Department of the Sheffield Gas Company, said an entirely new method for the heat-treatment of steels and alloys had been developed in Sheffield during the past twelve months. It was well known that the makers of furnaces had advertised furnaces for many years as being capable of heating steel without forming scale. A few of these manufacturers had said they could heat steel with a minimum of scale, but until a few months ago he had never seen a furnace that would heat steel without forming scale. The Sheffield Gas Company had been giving close attention to this matter of heating steel by gas, and he could now honestly claim that this could be done without forming any scale and without decarburisation. A process had now been developed by which, without any doubt whatever, steel could be heated to a temperature as high as 1,350 deg. C. without a trace of scale, and he could guarantee also no decarburisation. The process had been demonstrated recently to only four firms in the trade, but one of these firms had already stated that in all their experience of the manufacture of twist drills they had never been able to make a drill to compare with those made by this process.

XUM

Sound Non-Ferrous Castings.

The Leicester College of Technology was the venue of the meeting of the East Midlands Branch of the I.B.F., held on Saturday, October 22, 1932. A Paper was given by Mr. F. W. Rowe of Huddersfield on "Some Factors Influencing the Production of Sound Non-Ferrous Castings."*

DISCUSSION.

The Branch-President (Mr. C. W. Bigg), thanking Mr. Rowe for his address, said that it was seldom the Branch had a non-ferrous Paper, as its members were mainly connected with the production of cast-iron and malleable castings, but it was also seldom that a Paper was given in a more interesting manner than had been given that night.

Mr. Peace (Derby) said one point connected with the use of electrolitic copper wire; had an attempt been made to get over the difficulty by briquetting the wire? In connection with the wheel blank illustrated, did he understand that the runners were on a chilled surface? He was not quite clear on that point, but it sounded rather contrary to general practice. Had Mr. Rowe any experience of a quantitative method of measuring liquid shrinkage; as far as he (Mr. Peace) knew there was no method at all satisfactory.

Briquetting Copper Wire Scrap.

Mr. Rowe said the wheel blank illustrated was run on four bosses. All bosses were chilled with the exception of the four upon which the casting was run. The briquetting of copper wire scrap did effect some improvement, but the methods at present in use for briquetting do not pack sufficiently tight to prevent absorption of the furnace gases. Really the only way to bring back copper wire was to melt in the reverberatory furnace under a proper refining process. As to the quantitative method of measuring liquid shrinkage, he was afraid that he, too, had no really definite method.

Material for Chills.

Mr. P. A. Russell (Leicester) said Mr. Rowe had stated he melted under slightly oxidising conditions. His own experience was contrary to that, he generally melted with a covering coat of charcoal to prevent oxidation. He asked how was the density figures obtained. For deoxidation, phosphorus and zinc were used, but had Mr. Rowe any information as to whether the use of both at once was harmful? What material did Mr. Rowe use for his chills? He had noticed that melting conditions had been emphasised. Whilst agreeing with the precautions taken in melting, he had thought casting temperature of most importance. He had had troubles with castings, and on remelting and casting at a lower temperature had eliminated those troubles.

Mr. Rowe said he had perhaps not made his remarks on melting under a slightly deoxidising condition quite clear. In the higher phosphor alloys, it was essential to melt under a layer of charcoal. His remarks had referred to bronze castings. Brinell tests necessitated cutting up the castings, but the density test merely required the weighing of the casting in water and in air, which gave density figures that were quite accurate. The variations due to casting and melting conditions were very much more than those due to variations in composition. As to the use of phosphorus and zinc for deoxidising, he had no objection to a small amount of phosphorus when zinc was present. Zinc up to 2 per cent. and phosphorus up to 0.2 per cent. were not deleterious. The material for chills varied according to the degree of chill required. Copper was the most effective chilling material. Cast iron could be used where the chill was not heavy, and lump graphite could be used for a lesser chill. He thought most people placed too much importance on casting temperature and not enough on melting conditions.

Virgin Metal or Ingots.

Mr. Lucas (Loughborough), speaking with reference to raw materials, asked whether the author preferred to use virgin metals or prepared ingots? As copper-wire scrap was very prevalent to-day, would Mr. Rowe say whether there was any objection to first melting the wire and running into ingots and then using the ingots for casting? Which was the better method of using borings and turnings from the machine shop, as received or remelted and poured into ingots? When such borings were wet from the cutting compounds would that cause trouble? When making phosphor bronze, did the author cast from the first melt, or did he prefer to remelt? What was the composition of the sand moulds and how did the author get the beautiful skin shown on the sample castings displayed?

Mr. Rowe said different brands of copper ingots varied in the gas content, and in his practice he definitely limited the amount of virgin metal. All virgin metal did give trouble due to the gas content of the metal. He limited its use to 30 per cent. in any one mix. When making phosphor-bronze castings, for the best jobs he definitely preferred ingotted metal. The troubles due to shrinkage or porosity are distinctly less in a metal that had been ingotted. As to the use of borings, that problem had to be solved. He preferred to melt alone and ingot and analyse them before using for castings. He never used borings direct into a mixture. He had found that the cutting-compounds used contained substances that were likely to cause trouble. He did not use any coal dust in the sand moulds for bronze castings. Fully 60 per cent. of their bronze castings were made by centrifugally casting in steel moulds. When sand castings were made, they used a fine-grained sand, no coal dust was used, the moulds being lightly dusted with plumbago. The plumbago was dusted on and not sleeked. They used oil sand for cores and moulds to give the best permeability.

The Use of Chills.

Mr. Hillman asked whether the author prepared his chills and with what preparation. Did he have the trouble of metal striking into the core and the mould and how did he prevent it?

Mr. Rowe said that cast-iron chills were hopeless if cold or rusty, and just as bad if too hot. His experience was that cast-iron chills should be used at a certain temperature. Below 100 deg. C. unless coated with graphite caused trouble, also if the chill was above 400 deg. C. trouble again occurred. Old chills were the best. New chills were dangerous, and it was well worth while to look after the chills carefully. Metal eating into the sand mould was a common fault, and the nature of the sand used may be the cause. Some of the sands may be course grained, yet not necessarily permeable, and thus liable to give trouble. Also, some types of oil sands would require a good coating to prevent the metal eating in.

The Tensometer.

Mr. Blandy (a visitor and member of the Technical College staff) said he was very interested in the figure put forward on test-bars cast on to the castings. The remarkable difference given by the test-bars and the castings were very instructive. With regard to the cutting up of castings, he noticed the author exhibited some test-pieces for the Tensometer, and he would be glad if the author could give his experience of that machine. The college had installed one of those machines, and he would be grateful for Mr. Rowe's opinion of it.

Mr. Rowe said he had found the Tensometer to be invaluable for exploring castings. The results were reasonably accurate. There was no doubt for investigating the strength of various points the machine was a definite boon. Before he had to rely on indications of hardness tests alone, and he had now a machine that would give definite figures of small sections.

Mr. Spiers had been interested in the difference between the test strength of the castings and the test-pieces cast on. What would have been the difference if the casting had been run through the test-bar? Did the author know anything of tungsten-copper? Was it melted in the usual way, and could it be forged?

Mr. Rowe said probably some difference would occur if the castings were run through the test-bar. The method, however, was to run in four places, in the case of the wheel blanks. He did not know that it would influence the question of mass. He had very little practical knowledge of tungsten-copper to give Mr. Spiers. He had made laboratory tests of some weird and wonderful alloys and had some wonderful results, but in actual practice those results had often broken down.

Mr. Blades (Syston) asked whether Mr. Rowe could indicate if there was any way of hardening the skin of the castings? When pouring in iron moulds should the pouring temperature be higher or lower than in sand moulds? For cast-on test-bars, was there any definite place to attach them? In castings of various sections was there any trouble due to cracking?

Mr. Rowe said that the hardening of non-ferrous alloys was in its infancy, but there was no reason why some alloys should not be case-hardened like steel. If one was using an iron mould it is essential to cast at a higher temperature. The placing of test-bars was a question that was at present occupying the attention of the non-ferrous committee of the Institute. In his practice he had found no objection to placing it horizontally on the top joint of the mould. In heavy bronze castings they did not have the trouble with cracking as in steel.

A vote of thanks was proposed by Mr. P. A. Russell, and seconded by Mr. T. A. Spiers, which Mr. Rowe acknowledged.

* Foundry Trade Journal, November 10, 1932, page 282.

Three furnaces at Messrs. Baldwin's steelworks, Landore, Swansea, have been in operation this week. The mill department is also being restarted, and it is expected that the two remaining furnaces will be lighted in a few weeks.

Determination of Oxygen in Steel.—An extension of the hydrogen-reduction process for the determination of oxygen in steel was described by Dr. E. Czernak and the late Prof. O. v. Keil-Eichenthurn in a recent issue of "Archiv für das Eisenhüttenwesen." The carbon monoxide, formed in addition to the water vapour, is converted into dioxide by means of iodine pentoxide, but instead of determining the amount of iodine liberated the carbon dioxide is absorbed in a solution of barium hydrate and titrated with oxalic acid. Oxygen determinations on low-carbon basic steels showed that: (1) The figure of 0.2 per cent. in silicon-free steels, which has so far been regarded as the permissible limit for the application of the simple hydrogen reduction process, must be abandoned, since even much lower carbon contents can give rise to considerable errors. (2) The proportion of the total oxygen which is reduced by the hydrogen is affected by the method of combination of the oxygen with iron and manganese, increasing with increasing proportions of MnO to FeO. In consequence the application of the supplementary process depends not on the carbon content of the sample but on the manner in which the oxygen is present in combination.

A Phase of Recent Research in Foundry Technique.*

SOME OBSERVATIONS ON THE USE OF SODA ASH.

By N. L. Evans. B.Sc., A.I.C.

(*For illustrations see pages* 333 *to* 336.)

The demands of present-day engineering have resulted in vast changes in cast iron as a structural material. Mass production of high-grade castings, as used, for example, in the motor industry, necessitates a degree of regularity in composition, and freedom from minute surface and internal defects, only rarely called for in the past. Uniform machining qualities must be combined with satisfactory resistance to wear. The strength of the material must meet the tendency of designers to reduce sections and make components lighter in weight. The addition of alloying elements, such as nickel and chromium, can only be considered worth while if the iron used as a basis is of good quality. The same proviso must be made in the case of high-test irons. Lastly, but by no means least in importance, the use of castings as pressure vessels of any kind whatever, particularly in view of the known advantages of the cast structure for resisting deformation, calls for the removal of the stigma of unreliability which has so often prevented the products of the iron foundry being considered, owing to the difficulty of detecting internal cavities. Modern methods of scientific control are bringing the time nearer when the well-made iron casting will be regarded, in its own particular sphere, as being just as reliable as an alloy steel forging.

General Influence of Soda Ash.

Soda ash (sodium carbonate) is rapidly establishing itself in this country as one of the cheapest means of improving the quality of cast iron and helping it to meet the modern demands alluded to. First used simply as a desulphurising agent, it has been found subsequently to have a marked refining and degasifying action on the metal. It helps in the production of sounder castings, which can also be more easily dealt with in the machine shop; and, as will be shown in the course of this Paper, its effects on the economic side of foundry work cannot be neglected, in the face of present-day competition.

Some of the branches of the iron industry in which the soda-ash process has already gained a firm footing are:—The manufacture of refined pig-iron and alloy pig-iron; heavy grey-iron castings, particularly those used in chemical plant; converter steel castings; malleable castings; and motor-cylinder and other high-grade castings which are required to withstand pressure.

Two Processes Available.

For the benefit of any who may not yet be familiar with the use of soda ash, it may be explained that it is available in two forms for foundry use. In the form of a granular powder ("dense soda ash") it is used in the ladle or receiver, being simply thrown into the bottom and the metal being tapped on to it. After allowing time for the reaction to take place, the fluid slag which rises to the surface is thickened with ground limestone and removed with a deslagging tool. In the case of large castings, there is practically no increase in the time taken, as the metal frequently remains in the ladle for half an hour or longer. The reaction which takes place is exothermic, and the fluidity of the iron is increased by the removal of sulphur. Table I shows a number of typical analyses of metal before and after treatment in this manner.

When time is a vital factor, as in cases where small hand shanks are filled direct from the cupola for making castings of thin section, or in casting white iron for malleable, which requires a very high temperature; then sodium carbonate in the form of fused blocks is recommended. The blocks weigh four pounds each, and are added to the cupola charge at the same time as the limestone. This method of using soda ash is not quite so efficient as the ladle method, from the point of view of reduction in sulphur, but it has a very marked effect on the general structure of the metal. Table II gives some typical effects of cupola treatment on analysis.

TABLE I.—*Effect of Soda Ash on Sulphur and Manganese Contents.*

(LADLE METHOD.)

Before Treatment.		After Treatment.	
S per cent.	Mn per cent.	S per cent.	Mn per cent.
0.092	0.36	0.047	0.47
0.111	1.02	0.065	0.96
0.086	0.40	0.044	0.45
0.19	0.24	0.07	0.27
0.048	0.31	0.028	0.32
0.100	—	0.020	—
0.230	—	0.074	—

TABLE II.—*Effect of Block Soda on Sulphur Contents.*

(CUPOLA METHOD.)

Sulphur Content.	
Before Treatment.	After Treatment.
0.12	0.07
0.060	0.048
0.093	0.080

Both forms in which the reagent is available consist of pure anhydrous sodium carbonate, and the amount used is usually 0.5 to 1.0 per cent. of the weight of iron treated. In the manufacture of refined iron, and in the converter steel process (to give two typical examples) the actual removal of sulphur is of primary importance, and if this were the sole effect of sodium carbonate, it would still have a very wide application. But the main object of this Paper is to deal with some of the additional applications, which bring the process within the range of interest of almost every foundry except those engaged on the lowest grades of work, where the quality of the iron is of little importance.

An Aid to Sound Castings.

The production of sound castings is of primary importance. Unsoundness may be due to a variety of factors, amongst them being non-metallic inclusions of the manganese sulphide type, which have a marked tendency to segregate; mechanically entrapped dirt; a high gas content; an open grain; and faulty design. Do not let it be thought that extravagant claims are made for soda ash. It is not a universal panacea for every foundry ill. But it does have a marked influence in ameliorating the defects enumerated above.

To demonstrate this, two test-bars were cast from the same material, namely, very dirty pipe scrap, of the following analysis:—Total carbon, 3.25; silicon, 2.3; manganese, 0.46; sulphur, 0.098; and phosphorus, 1.45 per cent.

The test-bars were 1¼ in. dia. and 15 in. long, and they were cast without heads, so that all the contraction cavities, etc., would be in the bars themselves. The metal was melted in a small induction furnace, the first melt being cast without any treatment, and the second melt being treated with about 1 per cent. of soda ash; and Fig. 13 shows the section of the upper 4½ in. of each bar. The untreated one is riddled with gas holes at the top, and has a large central cavity, below which there is a dirty porous core. The one treated with soda ash has a slight depression in the head, below which the metal appears to be perfectly sound.

How Soda Ash Operates.

The explanation of the change is fairly obvious. One of the most common methods of degasifying molten metal is by agitation. Sodium carbonate melts at about 850 deg. C., and at the temperature of molten iron it forms a very fluid slag. Moreover, an evolution of carbon dioxide takes place which causes the slag to boil and agitates the melt. In the case of a ladle or receiver with soda ash in the bottom, the reagent melts almost at once, and the stream of metal coming from the cupola spout has to pass through the boiling slag, which stirs the metal and becomes mixed with it. The melt is thus degasified whilst quite fluid, so that the amount of gas left to come out of solution during solidification is negligible. As soon as the stream of metal stops, the slag begins to rise to the surface, which it does very easily on account of its thin liquid nature; and it carries with it any particles of dirt which may be entrapped in the melt. Manganese sulphide is reduced to metallic manganese. The analyses in Table I showed in most cases an increase in the manganese content of the treated metal, for the reason that much of the manganese sulphide which would normally slag off and be lost, is reduced, and the manganese is returned to the melt. Moreover, this manganese is present as metal in solution, instead of non-metallic sulphide, which, when it segregates, may be a source of mechanical weakness and porosity, and a cause of preferential corrosion.

Internal Structure of the Iron.

It has frequently been observed that test-bars cast from metal treated with soda ash have a finer and more uniform fracture than test-bars of the same metal not treated with soda ash. It is very desirable in many instances that the grain of a casting should be as nearly as possible uniformly fine. Very big variations in section are often present in the same castings, and the thick sections should be as sound as the thin ones. This is often not the case. For example, a piece of chemical plant may have a boss cast on it, which is subsequently to be drilled and screwed for joining on a pipe to convey some moderately corrosive liquor. It is not of much use to spend time and money ensuring a casting surface free from blemish if the centre of the boss is open grained, with coarse graphite flakes, each one a potential canal along which corrosive action can take place.

Fig. 2 illustrates the effect of soda ash in this connection. It will be seen that not only is the graphite finer in the bar treated with soda ash, but there is very little difference between the outside and the centre; whereas in the untreated bar, the graphite, which is reasonably fine on the outside, is very coarse indeed in the centre. The bars in this case were ordinary 2-in. by 1-in. by 42-in. transverse test-bars, and in the case of the treated one, the soda ash was applied in the ladle.

Influence of Soda Ash on Graphite.

Fig. 9 illustrates the same refining action on the graphite, but in this case the metal was treated with fused sodium carbonate in the cupola. The test-bars were 1 in. square in section and the two photomicrographs were taken in the same relative positions in the treated and untreated bars. The refining action is not confined to the graphite, but appears to affect

* A Paper to be read before a Joint Meeting of the British Cast Iron Research Association and the London Section of the Institute of British Foundrymen, Sir Harold Hartley, F.R.S., presiding.

the pearlite as well. It has been repeatedly noticed that, using, say an 8-mm. objective, the pearlite in untreated iron can be readily resolved, but in treated metal an appreciably larger proportion is not resolvable. This is illustrated in Fig. 5.

A further enlargement of the structure of the same samples is shown in Fig. 4. The apparent "fineness" of the pearlite in a given sample, as has been shown by Belaiew, depends on the angle at which a particular pearlite grain is sectioned. The actual "fineness" depends on the velocity of cooling through the Ar_1 transformation, and the degree of supercooling which takes place. In the pair of samples now being considered, there is no reason why either velocity of cooling or degree of supercooling should have varied, as both bars were cast under similar conditions. But there can be no doubt that the pearlite lamellæ appear to be much more closely packed in the treated sample.

The explanation of this refining action is at present a matter of conjecture. So far as the graphite is concerned, the agitation of the melt in the ladle may cause a mechanical breaking up of the graphite flakes. This, of course, would not apply in the case of cupola treatment. A much more fascinating theory from the metallurgists' point of view is that sodium compounds may exert a modifying action on the graphite, comparable with the very familiar but little understood modification of the aluminium-silicon alloys. As regards the refining of pearlite, Colbeck has made the interesting suggestion that it may be due to what is really a change in composition. The manganese content remains, broadly speaking, the same, but in the case of metal treated with soda ash, much more manganese is present as metal in solution, instead of existing as manganese sulphide, and in consequence it might be expected to have a more profound effect on the structure.

But whatever theoretical explanations may be advanced, it remains a fact of the utmost practical importance that, by the combined actions of desulphurising, degasifying and refining, foundries producing castings which have to pass a pressure test are finding that the percentage of rejects is reduced to a marked extent. Reference has already been made to the habit of segregation, which is typical of manganese sulphide. It is not only the amount of sulphur which is present in cast iron which matters. For many purposes, its distribution is of even greater importance.

It is, perhaps, unusual to prepare sulphur prints of cast iron, but this very simple and cheap method of testing is of particular interest to certain branches of the foundry industry. One or two examples will illustrate this point. Figs. 7 and 8 show the distribution of sulphur across the sections of 2-in. by 1-in. transverse test-bars. It may be noted in passing that both these Figs. give one the impression that the desulphurised samples have a finer structure than the untreated ones.

What Sulphur Prints Disclose.

But sulphur prints are much more striking when larger castings are involved. Fig. 1 shows the cross sections of two test-bars cast on pans weighing several tons and intended to hold corrosive liquors at high temperatures. The actual sizes of these sections are $3\frac{7}{8}$ in. by $2\frac{7}{8}$ in. and 3 in. square. The large test-bar has not been treated with soda ash and has a sulphur content of 0.09 per cent., and the small one has been treated with soda ash in the proportion of about 20 lbs. per ton of iron and has a sulphur content of 0.032 per cent., which is very evenly distributed throughout the mass of the iron, in contrast to the highly-segregated patches which occur in the untreated sample.

It is impossible to overestimate the importance of even distribution of impurities in all cases where corrosion is encountered. Segregations do not as a rule occur right on the casting surface, but they are frequently found just underneath the skin. In the example shown they are a little more than $\frac{1}{4}$ in. below the surface. They may be exposed initially if machining of any kind is called for, or it may be that the liquor in a pan contains highly-abrasive matter, which, in conjunction with the corrosive action, will wear away the surface until segregations are exposed. In either case, such segregations are practically certain to result in the rapid failure of the casting through the formation of a deep pit.

In actual practice, under conditions as severe as those in any branch of the chemical industry, it has been found that castings which have been treated with soda ash wear and corrode away evenly and show a much-reduced tendency to develop local pitting. It has also been observed that the casting skin of treated castings is much smoother. This is not only of interest from the aspect of resistance to corrosion, but may also result in considerable savings when castings have to be cleaned up, prior to enamelling, or similar finishing processes.

Machinability.

Turning now to the question of machining, it will be agreed that this is to-day a matter of considerable interest from the production point of view. Mass-production methods demand that a material be supplied in its most machinable condition consistent with other requirements, such as resistance to wear. The cost of modern cutting tools is high, but the cost of stopping machinery for constant re-grinds and replacements may prove to be even higher, not to mention the disorganisation of output which results from inability to run to schedule. The cost of machining is also often an even bigger item than the cost of the original casting, and considerable sums of money are wasted if, nearly at the end of the machining operations, a patch of dirt or porosity is exposed sufficient to condemn the whole component.

Soundness of material has already been considered, and for the moment only the question of hardness will be dealt with. A motor cylinder-block casting may be taken as a typical example, though it is not by any means the most difficult or complicated one. The thickness of the section varies from thin waterjacket walls to comparatively heavy flanges and bosses. The whole range has to be both machinable and sound, and certain parts have considerable demands made upon them for wear resistance; that is to say, the permissible limits of hardness are narrow. If the sulphur content of the metal is reasonably low, say less than 0.07 per cent., then it is comparatively easy to reproduce the required degree of hardness by controlling the total carbon and silicon contents, and, when desired, adding definite amounts of alloying elements.

The sulphur content is frequently high enough and variable enough to upset all calculations. It is by no means uncommon for cylinder iron to contain as much as 0.13 per cent. sulphur, and if it varies from this amount down to 0.07 per cent. it is practically certain that a proportion of castings will give trouble in machining, particularly on the top face. The author is familiar with one instance in which it was necessary to install a grinding plant to deal with this difficulty. The only alternative is to raise the silicon content, which will involve a sacrifice of wearing qualities and danger of porosity. But if the sulphur content is kept regularly below the suggested maximum of 0.07 or 0.08 per cent. by the use of soda ash, such difficulty does not arise.

Another factor which influences machinability is the amount of non-metallic inclusions of oxide and silicate in the metal. By reason of its fluidity and the opportunity it has of becoming well mixed in the metal in the ladle, sodium carbonate slags remove a very large proportion of such inclusions. Miller has recently published results showing that the use of soda ash in a forehearth resulted in an increase in machining speed of 23.3 per cent.

Fig. 6 shows typical oxide-inclusions in a cast-iron pan of about $\frac{1}{2}$-in. wall thickness. The presence of such inclusions resulted in large numbers of the castings failing when subjected to a simple water-pressure test. It is perhaps not so widely realised as it might be that these foreign inclusions have a marked effect on the physical properties of the material. This point is best illustrated by some specimens of malleable iron.

Use for Malleable Castings.

Fig. 3 shows the unetched structure of two samples of white-heart malleable. The same metal mixture was used in each case, but the one containing fewer non-metallic inclusions had been treated with soda ash. The analysis and physical properties are shown in Table III. It

Table III.—*White-heart Malleable Iron.*

	Untreated.	Treated with Soda Ash.
Sulphur, per cent.	0.118	0.081
Tensile strength, tons per sq. in.	25.18	25.38
Elongation, per cent. ..	5	8.7
Angle of bend, deg. ..	160	180
Angle of twist, deg. ..	267	419

will be observed that the increase in ductility as shown by the elongation, bend and torsion results, has been obtained without any sacrifice of tensile strength. Fig. 10 is a photograph of the actual bend and torsion test-pieces, the ones on the left hand being untreated and those on the right treated with soda ash.

The same diminution of non-metallic inclusions in black-heart malleable is seen in Fig. 11, where again improved ductility has been obtained, using soda ash, without any sacrifice of tensile strength. Table IV shows the physical properties of these two samples.

Table IV.—*Black-heart Malleable Iron.*

	Untreated.	Treated with Soda Ash.
Sulphur, per cent.	0.13	0.094
Tensile strength, tons per sq. in.	17.9	18.7
Angle of bend, deg. ..	57½	66

All these malleable samples were made under laboratory conditions, and undoubtedly those engaged in that particular branch of the industry can produce much better test figures with the better annealing facilities available. But the samples shown simply illustrate the improvement which can be obtained if steps are taken to free the material from as much foreign matter as possible. In America it has been found that, with open-hearth and air-furnace melting, which is now becoming more popular in this country, soda ash acts on the rather sticky slags which are usually formed, and makes them very much more fluid, and consequently better able to separate from the metal, carrying the impurities with them. The same increased fluidity has been observed in cupola slags when fused-soda block has been put in with the charge. Both black-heart and white-heart malleable founders in this country are now adopting this process. Cupola-melted black-heart work provides a field in which desulphurisation is essential if the best physical properties are to be developed.

Shrinkage.

Shrinkage is a factor which is of greater moment in the casting of low-silicon irons than it is in grey-iron practice, and the requirements of the designer, who so frequently fails to co-operate with the foundry, may often be met by the use of an efficient degasifying process. Such a process is probably appreciated most in those borderline cases where, perhaps, a sudden change in section results in the production of an aggra-

(*Concluded on page* 337.)

SOME OBSERVATIONS ON THE USE OF SODA ASH.

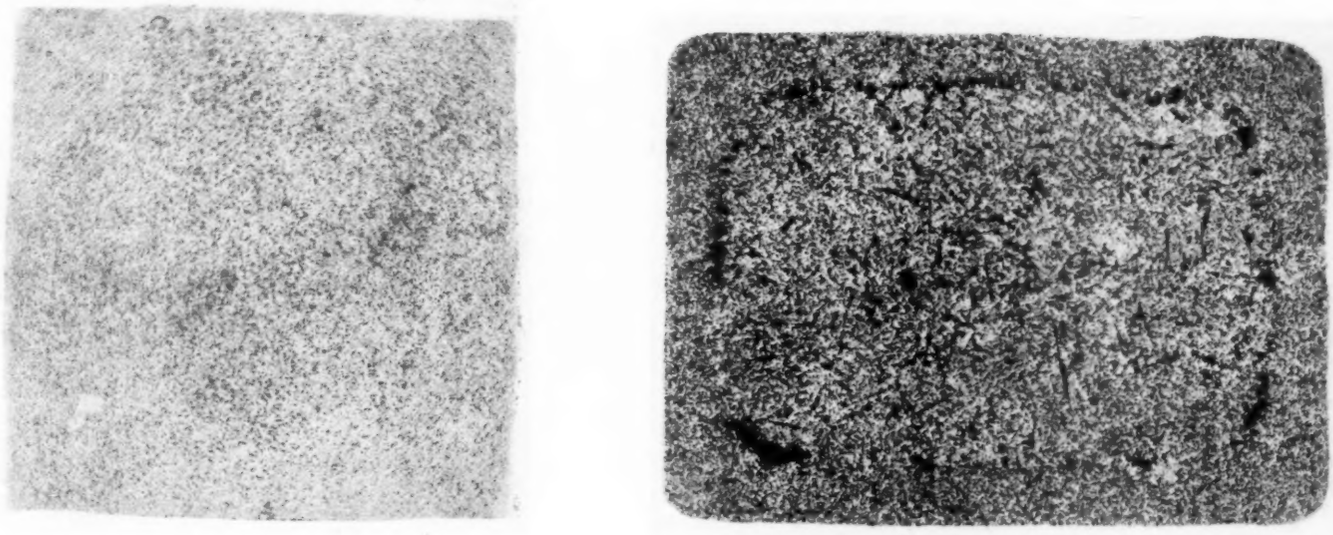


FIG. 1.—SULPHUR PRINTS FROM TWO TEST-BARS CAST IN PANS WEIGHING SEVERAL TONS. THE ONE ON THE LEFT HAS BEEN TREATED WITH SODA ASH. NOTE THE IRREGULAR AND DANGEROUS DISTRIBUTION OF SULPHUR IN THE ONE ON THE RIGHT.

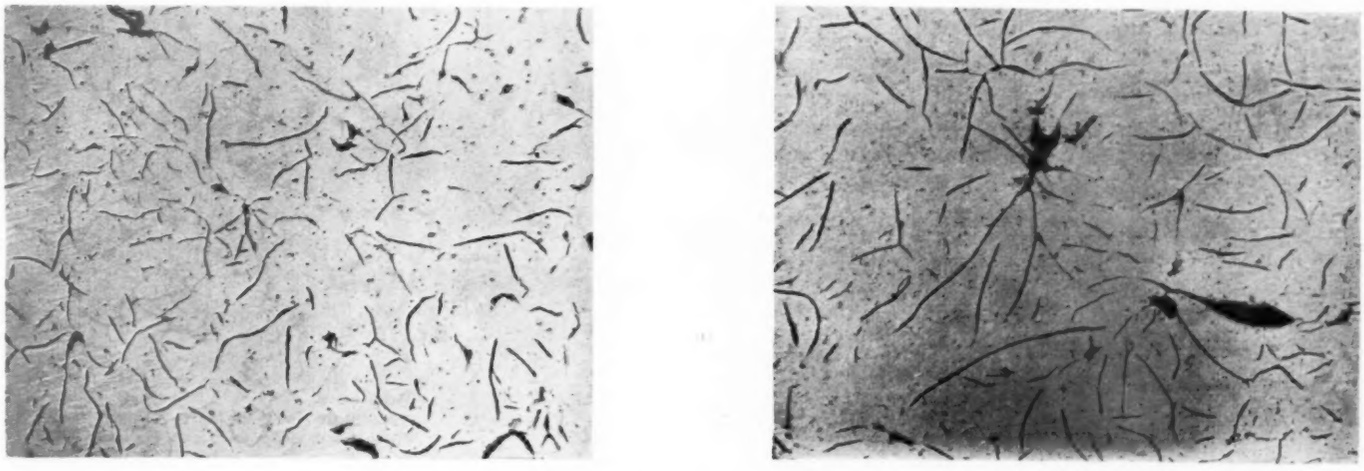


FIG. 2.—SHOWS THE INFLUENCE OF BRIQUETTED SODA ASH ON THE MICROSTRUCTURE OF CAST IRON. MATERIAL ON THE LEFT HAS BEEN TREATED BUT NOT THAT ON THE RIGHT. UNETCHED. × 200.

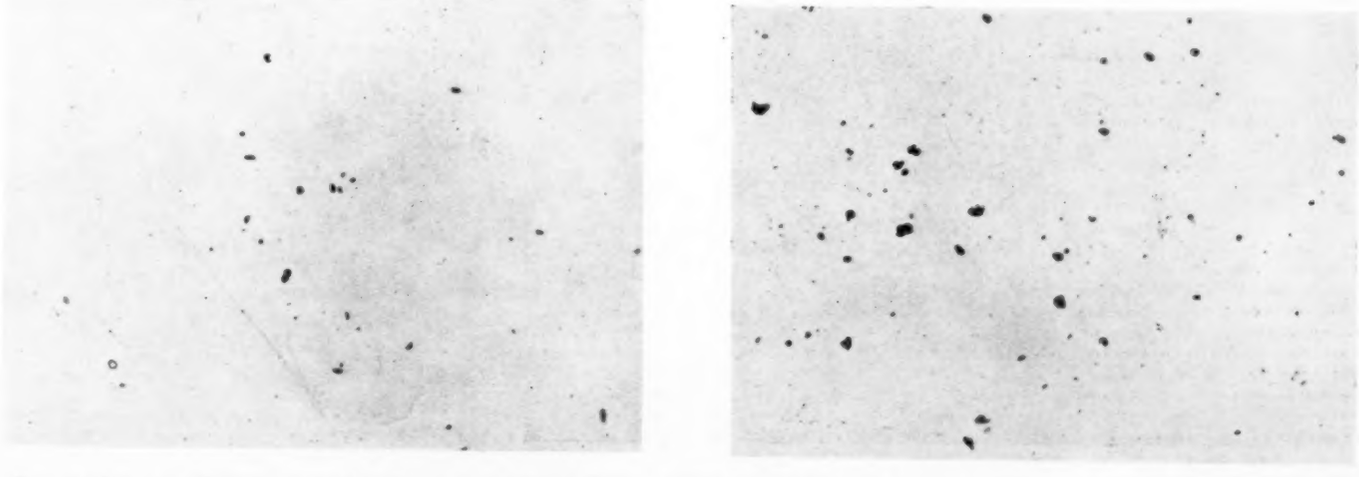


FIG. 3.—UNETCHED STRUCTURE OF TWO SAMPLES OF WHITE-HEART MALLEABLE. THE LEFT ONE HAS BEEN TREATED WITH SODA ASH. × 200.

Some Observations on the Use of Soda Ash (*continued*).

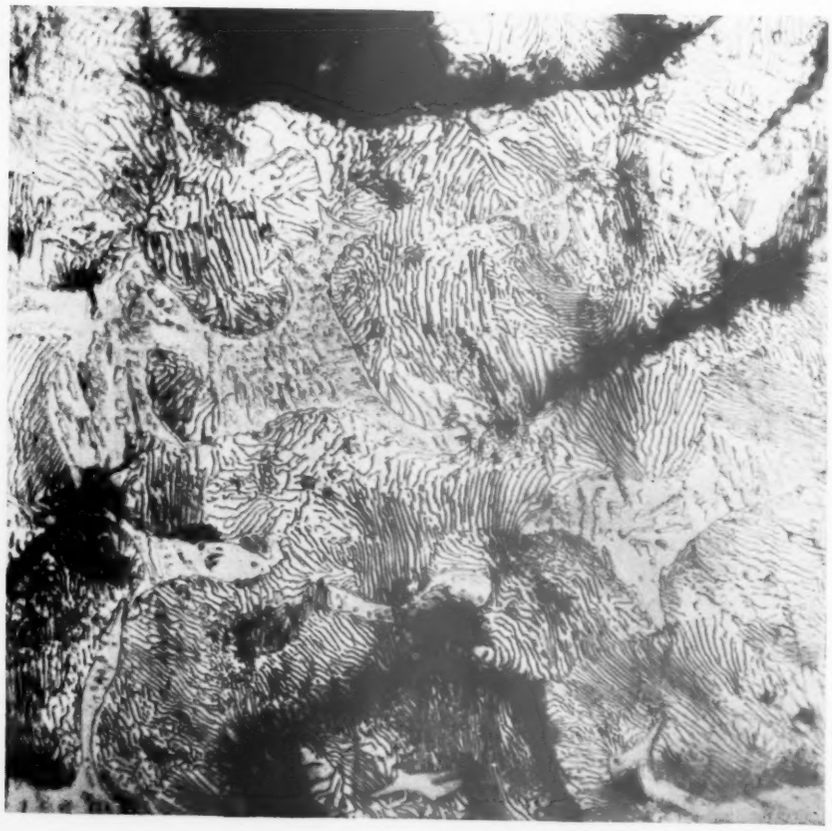


Fig. 4.—An Enlargement of the Micros shown in Fig. 5. The Upper is again the Soda-Ash Treated Material.

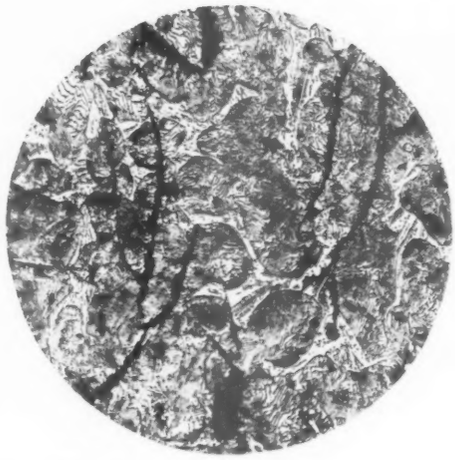


Fig. 5.—These Two Micros show the Effect of Soda Ash on the Pearlite as seen through an 8-mm. Objective. The upper has been treated, but not the lower.

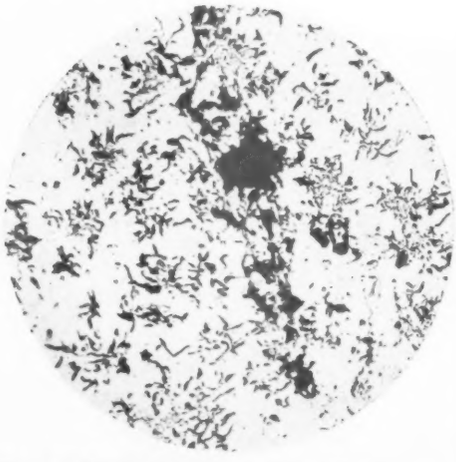
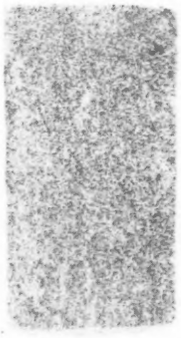


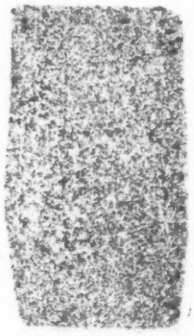
Fig. 6.—Shows a typical Oxide Inclusion of a Dangerous Character when found in Thin Sections. The Micro is Unetched. × 200.

XUM

Some Observations on the Use of Soda Ash (*continued*).



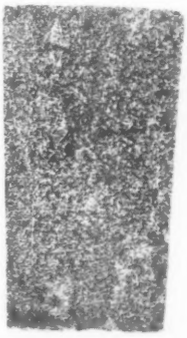
(Treated)



(Untreated)

FIG. 7.

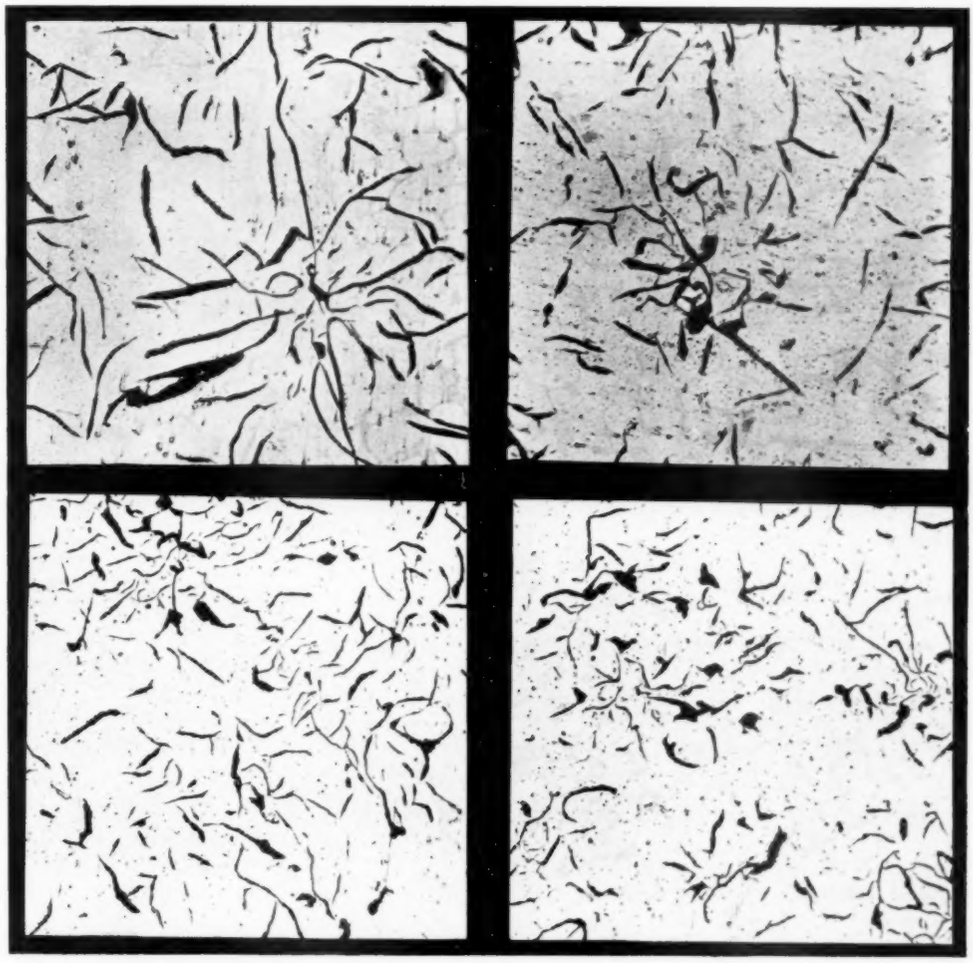
(Treated)



(Untreated)

FIG. 8.

FIGS. 7 AND 8.—SHOW THE SULPHUR DISTRIBUTION ACROSS THE SECTIONS OF 2-IN. BY 1-IN. TRANSVERSE TEST-BAR.



(Not Treated)

(Treated with Soda Ash)

(Centre) (Outside)

FIG. 9.—PHOTOMICROGRAPHS (× 100) UNETCHED, SHOWING THE INFLUENCE OF SODA ASH ON GRAPHITE FORMATION IN RELATION TO SECTION.

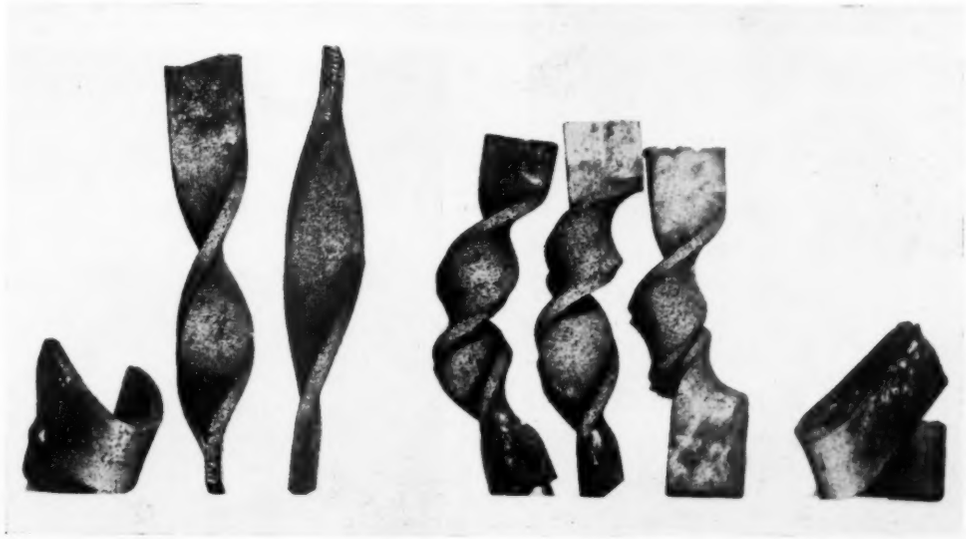


FIG. 10.—BEND AND TORSION TEST-PIECES. THOSE ON THE RIGHT HAVE BEEN TREATED WITH SODA ASH.

Some Observations on the Use of Soda Ash (*continued*).

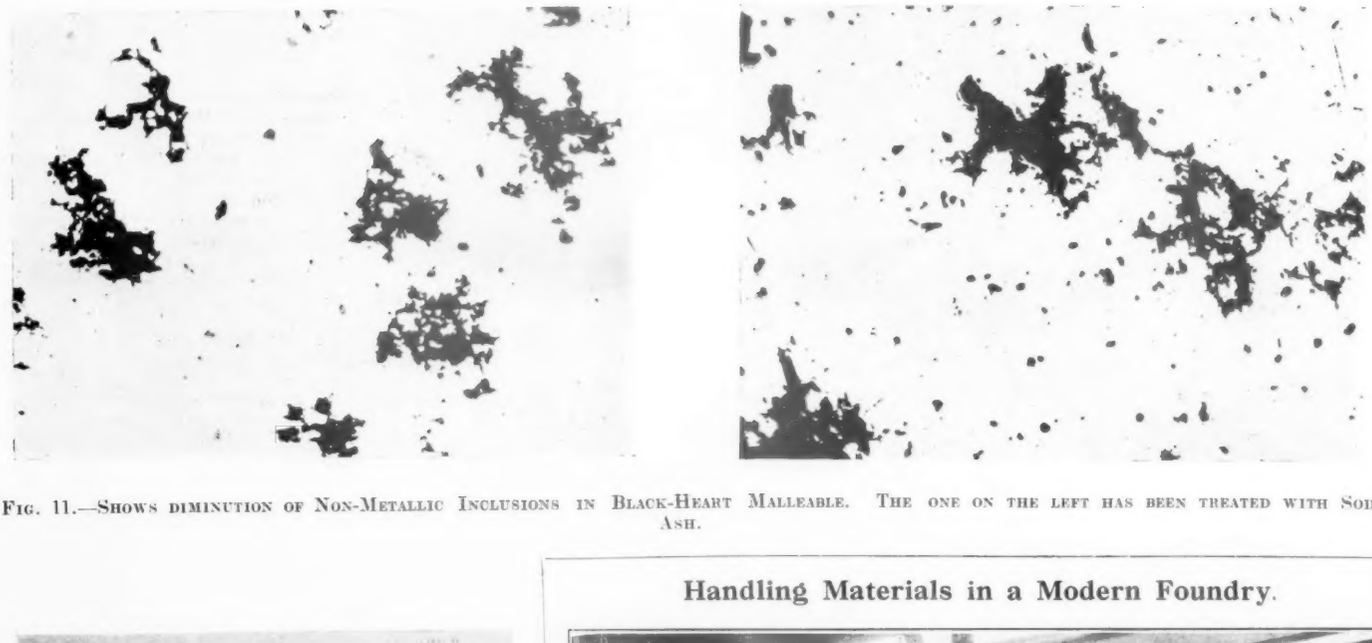


Fig. 11.—Shows diminution of Non-Metallic Inclusions in Black-Heart Malleable. The one on the left has been treated with Soda Ash.

Fig. 12.—The Type of Rake suitable for removing the Slag from Ladles.

Fig. 13 (Left) shows a Sectioned Bar made from Dirty Pipe Scrap after treatment with Soda Ash, and (Right) Untreated.

Handling Materials in a Modern Foundry.

Fig. 1.—The Transfer Carriage showing Electro-Mechanical Interlocking Gear.

Fig. 2.—General View of Foundry showing the Heywood Transporters.

A Phase of Recent Research in Foundry Technique.

(*Concluded from page* 332.)

vating percentage of wasters. The yield of good castings may, by such means, be appreciably increased.

Overcoming Difficulties.

In the ladle method of applying soda ash, it is important to remove the slag thoroughly before the metal is poured. It has already been stated that the thin soda slag is thickened by the addition of ground limestone. Limestone is a very cheap material, and should not be used too sparingly. In many cases, an amount equal to half the weight of soda ash used is sufficient, but long experience has shown that such factors as temperature have a profound effect, and it may be necessary to use as much as three-quarters of a pound of limestone per pound of soda ash. The limestone should be thrown into the middle of the melt (it may be wrapped in paper, or put in a bag for the purpose) and rabbled into the soda slag. This should result in the slag thickening up and forming dry lumps, and there should be definite signs of this taking place within thirty seconds of making the addition. If not, an extra shovelful or so added may make all the difference. Immediately thickening is accomplished, the slag should be raked off. The most suitable type of rake for the purpose is shown in Fig. 12. Various types of deslagging tools are favoured by different operators, but the one illustrated permits the most rapid removal of slag. The type using a wooden blade is quite good, as it is the same shape.

For removing the last traces of slag which sometimes cling to the ladle sides, there is nothing better than cheap foundry blacking, which, incidentally, may safely be added during the early stages of tapping when a large ladle is being filled. In this case it acts as an insulator, preventing undue loss of heat.

The question is sometimes asked whether the whole of the necessary soda ash should be added at once, when filling a ladle of, say, five or more tons capacity. The answer is that it should all be added at once, but many people have found it desirable to put about half a ton of metal in the bottom of the ladle first. This is said to lessen attack on the lining.

Good-Quality Limestone Desirable.

The purity of the limestone employed is a matter which affects the comfort of the operators. At a trial recently carried out, dense fumes were given off when the limestone, taken from a local supply, was added. This limestone was of a rather dark colour, and the main point revealed by an analysis was the presence of 2.76 per cent. of carbonaceous matter, which was, of course, responsible for the trouble. Buxton limestone is practically free from this impurity.

The use of sand as a slag thickener must be avoided, as a chemical reaction takes place, causing some of the sulphur to go back into the melt. For the same reason, cupola slag should not be allowed to run into the ladle. A little sand may, however, be thrown on to the melt when the major portion of the slag has been removed, as it will form a dam to hold back any minute traces which remain.

Receivers Advocated.

Perhaps it may not be out of place here to suggest the wider use in this country of the forehearth, with a tap-hole at the bottom. This in itself results in very much cleaner metal being run into the castings, and it materially reduces the cost of soda-ash treatment by eliminating the use of ground limestone and the time taken in slag removal. Foundrymen have sometimes been a little perturbed at the tiny yellow flames which are seen on the surface of a ladle of metal which has been refined with soda ash, and they have suggested that this indicates that slag is still coming away. It must be remembered, however, that the minutest trace of sodium will colour a flame yellow—the flame in this case probably being due to carbon monoxide. Careful analysis has only revealed 0.011 per cent. of sodium in treated iron.

Effect of Soda Ash on Refractories.

There is, of course, a certain amount of attack of this character, but in actual practice this has proved to be of no moment. In the case of ladles, the daub is usually renewed daily in any case, and the use of soda ash will not make its life less than a day, under ordinary conditions of working. When fused sodium carbonate is used as a cupola flux, it only makes contact with the lining at the slag level, which again is patched up every day. The usual effect is to produce a surface glaze which appears to be protective against further serious attack. Indeed it is often a very definite advantage, as soda ash invariably leaves a clean, smooth surface, instead of allowing hard lumps of slag to adhere, the removal of which by mechanical means is both costly and destructive. One large user has found that soda ash more than pays for itself on this account alone.

Some attack may be experienced in the case of receivers which are only relined at infrequent intervals. These are usually lined with firebrick, over which ganister is daubed. The trouble will not be serious if the brickwork is made with the thinnest possible joints. Scotch firebrick gives reasonably good results, but the difficulty can be entirely overcome by the use of brick containing an appreciable amount of alumina. The first cost of this is somewhat high, but it has several times the life of ordinary firebrick, and is cheaper in the long run. A graphite wash over the ganister daub also appears to be helpful.

Effect of Soda Ash on Constituents.

The effect of soda ash on the common elements other than sulphur in cast iron may be stated. Carbon and phosphorus are unchanged. Manganese, as has been shown, is slightly increased as a rule. Silicon may be lost, but usually not to a greater extent than 0.1 per cent. This is a variable factor, which seems to depend on the working of individual cupolas, and it may, of course, be overcome by a slight modification of the charge. The yield of certain alloying elements is increased to a small but appreciable extent by soda ash treatment. In particular this has been found in the case of chromium and molybdenum. When such additions are being made regularly the economic side of this may prove to be of considerable interest.

Economic Considerations.

The last phase of this subject to be dealt with is the economic one. Under present conditions, while there is so little work about and competition is so keen, any process which will reduce costs without sacrificing quality must receive consideration. It has been definitely proved that the amount of scrap in the cupola charge can be increased considerably if the refining treatment is applied. To quote only one example, in connection with the Tropenas process, a firm which previously used a mixture of 60 per cent. pig-iron and 40 per cent. scrap, found that they could reverse these figures, and use only 40 per cent. pig-iron with 60 per cent. scrap. This is an instance where a low-sulphur content is an essential feature. Owing to the 50 per cent. reduction in this element, which could be relied upon, it was found possible to use a locally-produced pig-iron, instead of obtaining a special quality from a distance. Yet a further saving was shown, because, without using soda ash, the pick-up of sulphur from the coke was always greater in the case of the first metal run from the cupola, on account of slower melting. Naturally, when this metal was blown to steel, it was necessary to use it only for unimportant castings, as it was of inferior quality. The removal of the sulphur, by soda ash, corrected this trouble.

It is, of course, impossible to quote actual figures, as customers are usually unwilling to supply these, and conditions and prices vary so much in different parts of the country. But, to take one very conservative hypothetical case, the average of a large number of pig-iron prices as quoted recently in THE FOUNDRY TRADE JOURNAL, was 62s. per ton. Good machinery scrap was quoted at 45s. per ton. If a firm were in the habit of using a mixture consisting of 50 per cent. pig and 50 per cent. scrap, and, by treatment with soda ash, they could change this to 30 per cent. pig and 70 per cent. scrap, the saving on material costs alone would be 3.4s. per ton. The average cost of the refining treatment may be taken as 1s. 9d. per ton, so that the net saving would be 1.65s. per ton of metal melted. Now many people are using scrap costing much less than 45s. per ton, and the use of soda ash has enabled up to 100 per cent. scrap to be used; so it would be easy to exceed the saving figure suggested.

But this is only one of the savings. Some of the others are enumerated in Table V, and to most of these it would be difficult to assign any definite figures. But their cumulative effect on the balance sheet would be very considerable in the course of a year's working, and the regularity and reliability of the treated products would be an incalculable addition to the goodwill of any foundry.

TABLE V.—*Potential Economics from the Use of Soda Ash.*

1.—More scrap and less pig in cupola charge.
2.—Use of cheaper coke.
3.—Fewer scrap castings due to unsoundness, &c.
4.—Smoother casting surface.
5.—Easier machining.
6.—Better corrosion resistance.
7.—Better yield of alloying elements.
8.—Cheaper grades or iron suitable for alloying.
9.—Better quality castings without increased costs.

TABLE VI.—*Some Applications of Soda Ash.*

High-grade blast-furnace pig-iron.
Cupola and open-hearth refined iron.
Alloy pig-iron and castings.
Grey iron castings.
White-heart and Black-heart malleable iron.
Castings for chemical plant.
Castings to withstand pressure.
Mass production castings.

In conclusion, it seems desirable to emphasise the fact that soda ash is not a quack remedy of unknown composition, but a well-known industrial chemical, approximately 100 per cent. pure, made in enormous quantities, and offered to the foundry industry at its ordinary market price.

Iron and Steel Output in October.

The National Federation of Iron and Steel Manufacturers reports that there were 59 furnaces in blast at the end of October, the same number as at the beginning of the month, two furnaces having commenced operations and two having been blown out. Production of pig-iron in October amounted to 275,600 tons as compared with 260,400 tons last September and 284,200 tons in October, 1931. There was a slight increase in the daily rate compared with September. The production included 58,400 tons of hematite, 134,200 tons of basic, 66,900 tons of foundry and 9,600 tons of forge iron. The output of steel ingots and castings amounted to 438,500 tons compared with 430,300 tons last September and 457,400 tons in October, 1931.

New Basic Bessemer Steel Works.—The news broadcast by the daily Press, that Stewarts & Lloyds were immediately to embark upon the construction of a 3½ million pound plant at Corby in Northamptonshire, would not come as a surprise to readers of this Journal. The project has repeatedly been referred to in our columns, the most recent being in an Editorial in our last issue. It should be realised that a very important section of the imports of steel into this country were made up of basic Bessemer steel, which is esteemed by manufacturers of tubes and jobs involving really deep drawing. The new works will obviously demand thousands of tons of castings for its construction and equipment.

Heat-Resisting and Corrosion-Resisting Cast Irons.

A meeting of the Falkirk Section was held in Falkirk on November 12, Mr. T. Shanks, the President, in the chair. The CHAIRMAN, in introducing Dr. J. W. Donaldson, said that while Dr. Donaldson had earned great fame in the West through his researches into heat-resisting irons and other metallurgical subjects, he, actually, was one of themselves, being a native of the district and had served an apprenticeship with Carron Company. They therefore were particularly pleased and proud to have the Doctor to speak to them on a subject of which he was so much a master. The subject with which Dr. Donaldson was going to deal was also one of particular importance to the district, as nearly all the foundries in the district had to deal with some castings which had to resist heat, and it must be the endeavour of all these foundries to improve those irons whenever possible to give them greater heat-resisting properties so that the quality of their products would gain further fame.

DR. DONALDSON then read his Paper, of which the following is an abstract.

The growth and scaling of cast iron with a corresponding reduction in strength has long been known as a phenomenon which has given considerable trouble to all users of this alloy, and many investigations have been carried out to determine the causes of such changes and to manufacture irons of suitable compositions to resist the influence of temperature.

Research work has established the fact that growth or volume change in grey cast iron is primarily due to graphitisation of the combined carbon, although oxidation of iron in the vicinity of the graphite flakes, due to the penetration of oxidising gases along the flakes, is also a contributory cause.

It has also been shown that volume changes occur not only at temperatures above the critical range, that is at temperatures above 650 deg. C., where they are usually accompanied by marked scaling, but also at temperatures below the critical range—temperatures as low as 250 deg. C. when subjected to such temperatures for prolonged periods.

In ordinary grey cast iron the lower the silicon content the better is the heat-resisting properties of the iron. Experiments carried out on a series of commercial grey cast irons with silicon contents varying from 0.65 to 2.2 per cent., heated for a period of 200 hrs. at 550 deg. C., indicate a critical silicon content between 1.1 and 1.2 per cent. With less than 1.1 per cent. silicon, the stability of the combined carbon is very marked, and is accompanied by little growth and slight reduction in strength, and this stability increases as the silicon content decreases. With over 1.2 per cent. silicon decomposition of the combined carbon is fairly rapid, and in the high-silicon iron 2.2 per cent. silicon is practically complete. Experiments have also shown that lowering the total-carbon content from 3.2 to 2.5 per cent. or increasing the manganese content from 0.5 to 2.5 per cent. have also a stabilising influence on the combined carbon, and that this increased stability is reflected in the resistance of the iron to volume changes and reduction in strength.

In addition to composition, structure plays an important part in the properties of these irons. It is essential that the graphite is in as finely a divided state as possible, as large flakes of graphite allow the penetration of oxidising gases into the interior with subsequent oxidation. Heat-resisting irons are therefore developed by having an all-pearlitic structure with finely-developed, well-distributed graphite, and in order to produce such irons it is necessary to adjust the total-carbon and silicon contents and regulate the casting temperatures and rates of cooling. The phosphorus content is also reduced in order to diminish the proportion of the phosphide eutectic present. The production of such irons brings about difficulties in manufacture, but these have been overcome by the use of special cupolas, air furnaces, and the hot-mould process of casting. Engineering castings for such parts as cylinder liners, pistons, cylinder covers, in which growth or volume change is reduced to a minimum and which withstands pressure well, are now made regularly with low-carbon, low-silicon contents, and a pearlite fine-graphite structure.

Alloy Cast Irons.

The effect of special element additions to grey cast iron and the production of alloy cast irons with superior properties as regards strength, both at ordinary and elevated temperatures, and resistance to wear has received a considerable amount of attention. Nickel and chromium are the two elements, which, as the results of many investigations, both in laboratory and the foundry, have shown the most promising results, and alloy irons containing those elements either separately or together are now in general use. The most satisfactory results with nickel are obtained by replacing the silicon in an iron of normal carbon content, nickel in the proportion of 1:3. The influence of the nickel is to refine the grain, increase the hardness, and reduce the depth of the chill in thin sections. Such irons machine well and have good wearing properties. This is a tendency, however, for graphitisation to take place in such irons when heated, particularly if the nickel and silicon contents are not properly balanced, and if the temperature is high.

Chromium, when added to cast iron, increases the strength, hardness and resistance to shock and wear. It has a stabilising effect on the combined carbon and a refining and hardening influence on the pearlite, and is in this respect similar to nickel but more powerful. With 0.4 per cent. chromium in the presence of 1.5 per cent. silicon the machining properties are not affected. The stabilising effect on the combined carbon due to the formation of chromium carbide is particularly noticeable at high temperatures, as chromium irons are very heat resistant. The influence of chromium on volume changes is to reduce those changes considerably both above and below the critical range, and in some cases to produce a contraction at temperatures below the critical range.

The alloying of both nickel and chromium in cast iron has proved very successful. Both elements have a hardening and refining influence on the pearlite, but nickel alone produces graphitisation and reduces chill, and at certain temperatures promotes growth and reduces heat resistance, whereas chromium increases the stability of the carbide, accentuates chill, increases the heat resistance at all temperatures and diminishes growth. By adding both elements in the proper proportions, the beneficial influences of both may be obtained and the adverse influences counteracted. With chromium additions up to 0.4 per cent., nickel may be added to counteract chromium in the ratio of three to one, the ratio varying slightly with the class of iron used and the amount of chromium added.

The addition of other elements such as tungsten up to 1.5 per cent., and molybdenum up to 0.5 per cent., which have been found by experiment to influence cast iron in a similar manner to that of chromium, although not nearly so powerful, have not been used in the manufacture of commercial irons. This is partly due to the high costs of such metals and the difficulties experienced in alloying. Vanadium in small quantities up to 0.25 per cent. has a beneficial effect on the strength properties, but produces graphitisation on heat-treatment.

Strength at Elevated Temperatures.

The strength of grey cast iron at elevated temperatures is also important and is closely related to the decomposition of combined carbon which takes place on heating. Strength at high temperatures is also influenced by creep in a similar manner to steel, but the determination of such creep is complicated by carbide changes. In general, the strength of grey cast iron in its cast condition at temperatures between atmospheric and 600 deg. C. first decreases slightly to a minimum about 250 to 300 deg. C., then rises to a maximum at 400 to 500 deg. C. before falling-off rapidly. Prolonged heat-treatment at temperatures below 600 deg. C. reduces the strength values, the diminution in strength depending on the composition of the iron and the temperature of treatment, and gives rise to temperature-stress curves, which fall off uniformly regularly. Such curves are of a similar nature to stress-temperature-time curves derived from creep tests.

Silal and Nicrosilal Irons.

In addition to those heat-resisting irons, which are of ordinary composition but of low-silicon content and to those produced by alloy additions, other heat-resisting irons have been developed recently. In 1928, as the result of investigations carried out by the British Cast Iron Research Association, it was found that by increasing the silicon content above 4 per cent. the growth of cast iron was diminished considerably at temperatures between 600 deg. and 1,000 deg. C. and was even less than that of low-silicon cast irons at similar temperatures. There was also practically no scale on a 5 per cent. silicon iron heated to 850 deg. C. for eight days. A new series of heat-resisting irons has therefore been developed by the Association under the trade name of "Silal." These irons contain over 5 per cent. of silicon, the average consumption being 5 to 7 per cent., as difficulty is experienced in machining irons containing over 10 per cent. silicon. The carbon content varies with the silicon content, being approximately 2.8 per cent. with 5 per cent. silicon and 1.6 per cent. with 10 per cent. silicon.

The normal structure of these "Silal" irons is a ferrite-fine-graphite structure in marked contrast to the pearlite-fine-graphite structure of the low-silicon heat-resisting irons. On heating irons with such a structure there is no decomposition of combined carbon and consequently no change in volume. The fine graphite structure also does not allow of the penetration of oxidising gases into the interior. In addition, the high-silicon content increases the scaling resistance of the material and at the same time raises the critical range of the iron.

High-silicon irons do not have the same high tensile strength as low-silicon irons due to the hardening influence of the silicon and are liable to cracking on sudden heating and cooling. To improve the strength and overcome this difficulty a grey cast iron known as Nicrosilal has been developed. This iron contains about 18 per cent. of nickel, 6 per cent. of silicon, 2 per cent. of chromium and 1.8 per cent. of total carbon. The structure of Nicrosilal iron is austenitic with fine graphite, and it possesses high-corrosion and heat-resisting properties. It is an iron which can be melted in a cupola, casts well, has good machining properties, is non-magnetic and has a high electrical resistance.

Silal and Nicrosilal irons are not recommended at present for engineering castings for prime movers, but they are very suitable for such parts as firebars, stoker links, furnace castings, melting pots, and retorts, where temperatures are high and where such parts have to be continually replaced due to growth and scaling, and where strength is not essential.

Corrosion-Resisting Irons.

There is no one universally corrosion-resisting cast iron, but a number of irons are manufactured which show a high resistance to corrosion of certain types. Silicon cast irons containing 14 to 15 per cent. silicon are practically unattacked by acetic, hydrochloric, nitric or sulphuric acids, hot or cold, concentrated or dilute. Caustic solutions, chlorides of sulphur, and sulphurous acid, however, attack them, and they are not recommended for use in such media. High-silicon irons of this type are sold under various trade names such as Tant-iron, Iron-Ak, etc.

Austenitic cast irons containing 12 to 15 per cent. nickel, 5 to 7 per cent. copper, 1.5 to 4.0 per cent. chromium, and 2.75 to 3.00 per cent. total carbon have high corrosion-resisting properties in such media as hydrochloric, acetic and sulphuric acids, and sea-water. If not so resistant to corrosion as high-silicon irons, they are stronger and are much more easily cast and machined. They are marketed under the names of "Nimol" and "Ni-resist."

Another alloy cast iron with corrosion-resisting properties is Nitricastiron. This is an aluminium-chromium cast iron produced for the nitrogen-hardening process, and the surface obtained after treatment not only shows a high degree of hardness, but is also highly resistant to corrosion. Corrosion-resisting properties are also noticeable in cast irons containing 2 to 3 per cent. of copper in such media as mine-waters, sea-water and weak acids.

DISCUSSION.

The CHAIRMAN (Mr. T. Shanks) said that they had listened to a most interesting lecture on heat-resisting cast irons. With regard to the use of alloy cast irons and with irons of the nicrosilal type containing large percentages of nickel and chromium, he considered their cost would be high, and in some cases prohibitive, when compared with ordinary cast irons. He had cast low-silicon cast irons for certain purposes and had found their use very satisfactory. As regards a 0.6 per cent. silicon iron and a 6 per cent. silicon iron, he would be glad to know if Dr. Donaldson had any comparative figures for volume changes when such irons were heated.

MR. URE asked if any differences were obtained in the heat-resisting properties of an iron made in the cupola from a pig-iron charge and of an iron of similar composition in which the charge was made up partly of steel.

MR. J. A. DONALDSON referred to experiments which had been carried out in which moulds were sprayed with aluminium before casting and asked what effect such treatment would have on the heat-resisting properties of cast iron so treated. Again, with reference to Nimol cast iron, copper was added to the extent of 6 per cent. He should like to know if such a high percentage of copper was necessary to produce an austenitic structure in combination with the nickel content.

MR. H. MCNAIR said Silal and Nicrosilal irons had been stated to give satisfactory results when used for parts such as firebars. What was Dr. Donaldson's experience with these irons when used for firebars, and how did they compare with irons of low-silicon content used for similar purposes?

MR. J. M. PRIMROSE said he knew of a case where articles cast in aluminium-treated moulds had collapsed suddenly after being in use for some time. With regard to the type of firebars cast in the district they obtained better results with their usual iron than with Silal and Nicrosilal iron. The iron used was one containing 2.5 to 3.0 per cent. silicon and the bars cast had a very hard skin. He had no experience of using low-silicon hot-mould irons for this class of work. So far as corrosion-resisting irons were concerned, he was doubtful if there was a large field for the application in chemical plant due to the recent development of other means of protection.

MR. N. ERSKINE asked if the repeating heating and cooling of cast iron produced different or similar results to that produced by continuous heating.

AUTHOR'S REPLY.

DR. DONALDSON, in replying to Mr. Shanks, said he had no comparative figures to offer for a 0.6 and 6.0 per cent. silicon iron, but there was no doubt both would show very little change at temperatures below 600 deg. C., while over 600 deg. C. he should consider that the 6.0 per cent. silicon iron would be more resistant. In reply to Mr. Ure's question, he might state he had compared a low silicon iron cast from a mixture of hematite and special pig-irons, with one prepared from a mixture containing 30 per cent. of steel and had obtained more or less similar results. Mr. Donaldson and Mr. Primrose had raised the question of aluminium and its influence on cast iron. Aluminium behaved in a manner similar to vanadium, acting as a deoxidiser and giving a refined grain with increase in strength, but aluminium also had a graphitising effect on the combined carbon when subjected to temperature.

With regard to Mr. McNair's and Mr. Primrose's remarks concerning Silal and Nicrosilal iron, he had no experience of their practical application. From his knowledge of their properties, however, he should consider them very suitable material for firebars. He could not understand how an iron containing 2.5 per cent. silicon gave such satisfactory results, unless it was chilled. Low-silicon iron had been extensively used for firebars, but ultimately failed, due to growth and distortion. In reply to Mr. Erskine's question, there was little variation in the results obtained by the two different methods of heating.

A vote of thanks, proposed by MR. SHANKS, was heartily accorded, and the meeting concluded.

Outlook for Copper.

By "ONLOOKER."

Rarely has copper been vexed by so many problems as surround it at the present time, and probably never in the history of the metal has the outlook been more obscure than it is to-day. The American Cartel is still functioning, but only as a shadow of its former self, while the imposition of duties in the United States and Britain have brought fresh uncertainties and complications into the picture. Add to these, doubt as to the outcome of the producers' conference on curtailment, the fears arising from international political and financial troubles, and the ups and downs of the sterling-dollar exchange and you have as pretty a picture of topsy-turveydom as anyone could hope to find.

At the time of writing the price stands at 5.45 cents c.i.f. European ports, which at the low point of $3.24 to which the £ has fallen gives an equivalent of about £37 10s. per ton, while standard copper is around £32, with a gold parity of about £21. Demand for the metal is very poor, partly because trade all round is bad but also particularly in regard to copper because consumers cannot bring themselves to trust the market even at this low level, and are not doing more than existing on a strictly hand-to-mouth basis. This is the kind of situation which confronts the producers in council, their deliberations being directed towards a settlement of the grievous problem of output curtailment during 1933. For the past nine months or so production of the principal world interests has been cut down to but 20 per cent. of capacity, but in spite of this it is not at all certain that stocks have not increased. In any case, they certainly have diminished very little and the tonnage of electrolytic available for consumers' use runs into nearly three-quarters of a million tons.

Arguments in favour of increasing world production appear on the face of it to be entirely absent, and it would certainly seem as if steps might well be taken to cut the rate of output still further in an endeavour to reduce the adverse balance of stocks. There are, however, certain difficulties in the path, one of them being the duty on electrolytic copper which is to be applied in this country and the consequent necessity for the Empire producers, particularly Canada, to turn out enough copper to supply consumers in this country. Much increase over the present rate is not necessary, for one at any rate of the Canadian producers has never reduced to 20 per cent., but it is possible that some addition will be found to be imperative. Another factor calculated to urge producers to turn out more copper is that in a few notable instances costs of production are so low as to make profits possible with copper selling at below 6 cents per lb., and obviously these profits would be increased were the rate of output raised.

In fire-refined copper the position is different from electrolytic, for here no large stocks exist and from time to time consumers have been even in some anxiety about their supplies. Application of the duty on this grade has been deferred until such time as the Empire can furnish the requisite quantity and quality, and it is, of course, quite likely that the producers concerned, one of whom apparently will not be represented at the conference, will insist upon a quota in excess of 20 per cent., for unless this be conceded there would appear to be quite a risk that the preference for Empire brands of this quality will never come into force.

That copper can ever be other than a relatively cheap metal in the future is unlikely, for modern methods have lowered production costs, and what is perhaps more to the point there are now available many sources of supply known but not developed twenty years ago. Inevitably these low-cost properties must force their way to the front and set up a price standard to which others must conform or perish in the economic struggle. That the price of the red metal is going to settle down at 5 cents is highly improbable, and it is indeed quite likely that some advance may shortly be seen, for in the opinion of a good many people adverse factors are largely discounted at the present price and the market is quite ready to move upwards to a modest degree as soon as some of the present difficulties are resolved. Of the ultimate level of copper it is impossible to speak with certainty, but between 7 and 8 cents is regarded as a likely range of values when world trade assumes normal proportions.

MESSRS. VICKERS-ARMSTRONGS, LIMITED, Barrow, have received an order from the Admiralty for the building of a submarine similar to the "Thames," built at Barrow and recently delivered.

B.S. SPECIFICATION FOR THE MARKING AND COLOURING OF FOUNDRY PATTERNS.—There are at the present time a number of conventions in use in this country in regard to the marking and colouring of patterns, the object of the markings being to indicate whether the article to be cast is to be in iron or in some non-ferrous metal, to indicate the position of cores, the seats of core prints, stop-offs, and whether machining is required. It is clear that it will be a matter of great convenience to the industry to have a uniform convention adopted so that all patterns reaching a given foundry will be marked in the same kind of way. A representative committee was formed and the matter very fully considered, with the result that a B.S. Specification has now been issued, standardising the colours for the various purposes mentioned above. Copies of the specification (No. 467—1932) may be obtained from the Publication Department, British Standards Institution, 28, Victoria Street, London, S.W.1. Price 2s. 2d. post free.

Industrial Russia of 1932.*

DISABILITIES OF DEFECTIVE ORGANISATION.

By Percy Fox-Allin (Associate Editor).

It is not intended, as it would serve no useful purpose, to enter into lengthy descriptions of the various factories visited; at the same time to enable one to form a true appreciation of the industrial conditions pertaining in Russia to-day, it is necessary to make certain references to the several works.

Ford Works at Nizhni.

These works are undoubtedly the best laid out and best-equipped works which have been developed under the Five-Year Plan. It may be recalled that the Soviet Government paid Henry Ford a very large sum for the plans of the works, specifications and 74,000 complete sets of parts for assembly; also to supervise the erection and to furnish engineers to put the plant into operation, and further to permit a certain number of Russian engineers to study the Ford plant at Dearborn. Henry Ford carried out his contract in the spirit as well as the letter, and the Nizhni Works are without doubt amongst the best laid out and equipped in the world. The general planning of the works is designed to make the fullest possible use of daylight, the light and heavy forge hammers being housed in two buildings in parallel, and these forming two sides of a square, the third side being a stamping-out shop. This is not only a very convenient arrangement for economic production, but the buildings are lighted from both sides.

The main machine shops are housed under one roof (about 1,980 ft. long by 330 ft. wide). A broad gangway extends for the full length of the building, the shops being laid off at right angles thereto, whilst the shop is equipped with a complete net-work of overhead telphers. The tool room and gauge rooms occupy mid positions and are enclosed from the general shops. The arrangement of the automatics and other machines is admirable, being singularly compact and yet affording ample working space.

A separate building is allocated to the manufacture of springs. In this shop are two continuous furnaces, one of the plate type for hardening and the other of the chain type for annealing. There are also two testing machines for testing laminated springs. Coil and spiral springs are made in a gallery which runs along one end of the shop. One of the main objectives of the writer's visit was to see the foundry, and although he strongly expressed this desire upon his entry to the works and apparently his guide was quite agreeable, it was arranged so that the end of the day was reached before the foundry. No explanation was offered, perhaps none is needed, as the method adopted to preserve from observation certain portions of a works is not altogether foreign to this country.

As already stated, the works and lay-out are excellent, but in their operation they are probably the most hopelessly inefficient in Soviet Russia, certainly a damning indictment. The real explanation is no doubt the complete failure to organise and run a Ford factory on Ford lines. The economic operation of such a works calls for the perfect balance of the whole of the processes and the maintenance of each process at the maximum of efficiency. To make such a works commercial, production must be intensive and wastage reduced to the narrowest limits. In the Nizhni Works there is a complete failure to appreciate the importance of efficiency in details. All the furnaces are oil-fired, but for the most part very inefficiently; one generally saw yellow flame and more or less dense smoke. In the furnaces serving the hammers the oil burners were working with an air pressure of 45 lbs. per sq. in. and the oil consumption was 200 kgs. (440 lbs.) per ton of billets heated.

It seems doubtful whether the testing machines in the spring shop had ever been used; at any rate it was impossible to witness a test, as the machines refused to operate. Perhaps it might be fairer to say the would-be operators did not understand their working. In the spiral-spring department, the foreman was anxious to demonstrate the method, but the two machines he first tried were out of order; a third machine worked after a minor adjustment. In the automatic-machine shop a woman was seen trying the finished parts with a micrometer, a tool which should never pass out of the hands of the skilled workman. These are trifling matters in themselves, but it is in the consideration of such details that we arrive at the true measure of overall efficiency or inefficiency, as the case may be. Waste may be estimated as at least 30 per cent.; indeed, it is probably very much more.

In view of the fact that those responsible are fully alive to the governing conditions, it is really astonishing no effort appears to be made to bring about the much-needed alteration. The Russian paper "Pravda" openly comments upon the blunders of organisation, the high labour turnover, which they state is intensified by the revolting living conditions, the undesirable equalisation of wages and the high percentage of waste.

"Amo" Works: Moscow.

The first portion of the "Amo" works was erected in 1915 to serve as a motor-repair shop. The works were considerably extended in 1922 and developed for the building of motors for old cars. Subsequently the works were practically rebuilt and laid out for the mass production of motor wagons, etc. It was at these works where the first motor wagon to be built in Russia was turned out. It was, however, not until last year that the works were actually put on mass production, and the writer was informed that during the succeeding fifteen months they turned out 30,000 wagons. At the time of the writer's visit the output was about 25 wagons per day; the falling-off in production was said to be due to a shortage of raw material. It might also be added that of the total steel delivered of Russian manufacture during a period of two months, 90 per cent. was bad, or, to express it more kindly, unsuitable.

These works are confined to the construction of 2½-ton capacity wagons which are fitted with a six-cylinder engine developing 65 h.p. and giving speeds up to 42 miles per hr. This works finds employment for 22,000, of which 22 to 25 per cent. are women, whilst there are 2,000 apprentices. The works were started up under the guidance of 11 foreign specialists, but of these only eight are now remaining. The buildings are lofty, well lighted and well ventilated, with an excellent system of dust extraction in operation.

The foundry is laid out on American lines, batteries of jolt-ramming machines being ranged on either side of a central gangway. Each line of machines is served by ball-bearing roller conveyors, along which the moulds are fed to the casting point; after casting they are travelled on to the knocking-out station. The sand falls on to a below-ground conveyor, which serves a bucket elevator at the sand plant, this last discharging on to a shaker screen; the sand then passes over a magnetic separator into the intensive sand mixer. The whole of the cores are hand made. The drying stoves are oil fired, the working temperature being about 200 deg. C.

The melting plant consists of nine cupolas, each of 12 tons per hr. capacity, and each tapped into a receiver. There is an electric furnace of 30 cwts. capacity for refining the iron for piston rings, etc. Pig-iron, both sand and machine cast, coke and other raw materials are stored over a wide area of ground, which extends for the full length of the foundry building. The ground is travelled by petrol trucks, but the whole of the material has to be man-handled.

Selmashtrov, Rostov-on-Don.

These works are very well laid out for the manufacture of agricultural machinery generally and "combines" in particular. Employment is found for 17,000, of which about 25 per cent. are women. We were informed that this works had turned out 1,700 "combines" in three months. At the time of the visit the output was five or six per day; this restriction of output was said to be due in part to the large number of repairs coming in, and in part to the depletion of labour in favour of agricultural work.

The foundry at this works was very well organised. About 140 tons of metal were melted a day, whilst 120 men produced 12,000 moulds per day. The work turned out of the shops was also well above the average of the Soviet factories. The general fabrication, riveting and spot welding was decidedly good.

Tractor Works, Kharkov.

These works are practically a duplicate of the works at Stalingrad, and were put into production in October, 1931; 12,500 hands are employed, of which 25 per cent. are women. Although the usual haphazard methods are in force for the storage of raw materials, as also for some of the heavier finished parts, the shops generally are better laid out for dealing economically with large outputs. No special reference need be made to the foundry; an annexe thereto, however, houses a small air furnace which is oil fired and serves for the production of the refined iron for rings, etc.

In the machine shop the advantages of an orderly arrangement is at once apparent. The gangways are marked out by strips of metal secured to the floor, and, unlike the other works visited, the gangways are kept clear of obstructions, thus giving free passage for the petrol trucks which travel the shop. There is a well-arranged system of overhead telphers. A battery of five process machines for gear cutting is served by a roller conveyor placed at machine-table height. The two forge shops are housed in separate buildings and in these shops the system of oil firing was very efficient; the furnaces are, of course, worked under slight pressure, but there was not a trace of smoke and the flame was clear.

The die shop is well laid out and its equipment includes a very fine die-cutting machine of the fully automatic type. The heat-treatment shop is well organised and in addition to a range of oil-fired furnaces there is a battery of electric furnaces. Steam for the hammers and other auxiliaries is raised in a battery of Babcock & Wilcox boilers which are fired with pulverised fuel; pulverising is done in ball mills; the waste gases are passed through a form of asbestos filters for removal of the fine dust, before being passed to atmosphere.

Needless to say, the works are hopelessly behind the formulated programme in the matter of productive output. Lack of metal and materials is no doubt largely responsible. The main factors are, however, lack of organisation and lack of individual responsibility. The output of the Kharkov works is often held up for the want of radiators which are made at the Stalingrad Works, but, on the writer's visit, operations at the last named were held up by shortage of material. Until it is made somebody's business to see that a proper balance is maintained, prodigious inefficiency must continue.

* A previous article appeared on October 27, 1932, page 247.

Locomotive Works.

The building of locomotives is not a new industry in Russia. In pre-war days the Russian shops turned out an average of 654 locomotives per year. The present developments are better described as bringing works into line with modern ideas and the erection and equipment of new works to meet the heavy requirements for the railways. For the time being the main works are Lugansk, Sormovo and Koluminskaya, and these three works are being considerably enlarged. The "plan" calls for 1,289 passenger and freight locomotives, 10 oil-fired locomotives, 24 electric locomotives and 150 of what are known as heavy industrial Moguls of the 2-10-2 type which are on the lines of the Baldwin model but of much greater hauling capacity. The first locomotive of this type was recently turned out at the Lugansk works.

Plans which may, or may not, be launched in the early part of next year provide for the building of locomotive works at Kuznetsk, which is situated in the heart of the Siberian coalfields, and at Orsk in the middle of the Volga country. Each of these works is to be able to build 500 locomotives per year. At Kashira, near Moscow, works are in course of erection for building electric locomotives; the assumed capacity of which factory is 1,000 locomotives per annum. It may be noted that the second Five-Year Plan provides for the electrification of 20 per cent. of the railway in the Soviet Union.

Summary.

The object of this series of articles was to deal, as briefly as possible, with the present condition of industrial Russia without any attempt to forecast future possibilities. The first Five-Year Plan so far as concerns the erection and equipment of works has been brought much nearer accomplishment than seemed possible at the outset; beyond this, however, the first Five-Year Plan has not been realised, because the works concerned are wholly uncommercial and one would not care to suggest how long a time it may take the Soviet Government to make them economical. It may, however, be reasonably assumed that they will ultimately do so. In the meantime they must pay for their experience, and because they elected to purchase that experience upon such a wholesale scale, their payment will be equally heavy. For many years, a longer period perhaps than they themselves at present anticipate, the Soviet must be large importers of machinery, plant, material and equipment.

When considering the present conditions of trading with Russia, it is only fair to remember that Russia is attempting what no other nation has ever been asked to do, or indeed what would not be expected even of a municipality; *i.e.*, to develop out of revenue. It must be obvious that whilst that condition pertains, long credits are a *sine qua non*. A very considerable volume of trade with Russia is being done by this country, but it is comparatively trifling compared with what might be done if we had something approaching normal trading conditions. In Russia there is a decided preference for machinery and plant of British manufacture. In this country there are a considerable number of manufacturers who would not hesitate to accept Russian business, but have perforce to let it pass, because they are unable to finance the work against the time required for the Government guarantee to become operative.

If we are to regain industrial prosperity it is essential that new markets should be found capable of being industrialised. The necessary conditions for such markets are (*a*) a large country rich in natural resources, but totally undeveloped; (*b*) a large population in a backward state awaiting the development of social amenities; (*c*) lack of transport facilities. At the present time there are three portions of the world which comply with these conditions, India, China, Russia. India is out of the question at the present time on account of the political situation; China on account of the absence of a centralised Government; and the only one of the three which is available is Russia, in which industrial development has already started at a rapid pace. Russia's purchases at the present time are limited only by her possibility of payment and such possibility is regulated entirely by the length of credits she is able to receive.

Clearly the only way to place Russian trade upon a normal basis lies in Russia being able to obtain long-term loans; it is equally clear that she cannot raise such loans within her own country. Certainly there are considerable difficulties surrounding the granting of such loans, but this country is probably in the most favourable position to do so. She is Russia's best, indeed for the bulk of her exports, her only customer and the trade balance is, of course, greatly in Russia's favour.

From conversations which the writer had with several influential financial men it was apparent that a suggested loan on the security of the imports would be favourably considered and that it might at the same time be possible to enter into an arrangement to liquidate the "old debts." Of course, the above possibility may have been thoroughly explored and turned down for sufficiently good reasons. If that is so it only remains for the Government to improve very materially the conditions of their guarantee and so enable the British manufacturer to be in a position to accept Russian orders. A point should be strained in this direction. Payment of the dole is an unfortunate certainty, whereas the possibility of the Soviet defaulting is very remote, and, if for no other reason, because their industrial and national life depends upon their not doing so.

There is one point which has not been touched upon, *i.e.*, the gold-mining activities of the Soviet. This, indeed, was the one phase of Russian activities upon which not the slightest information was available or could be obtained. This may be explained in one or two ways. On the one hand it is not desired to advertise how small the quantity is; on the other—and this seems the more probable, because it is known that the deposits are rich—considerable quantities are being won, and the gold accumulated as a safeguard against the possibility of European ports being closed against Russian exports, when, of course, the Soviet would only be able to purchase with sterling.

Congratulations.

We extend on behalf of the foundry industry heartiest congratulations to Messrs. Purimachos, Limited, of Bristol, on the attainment of their 50th anniversary. They executed their first order in November, 1882, which marked the introduction of a new product—a plastic fire cement. The name Purimachos was probably coined because the founder of the company, the Mr. John Charles Morgan, before commencing in business was H.M. Consul in Brazil—hence its Spanish or Portuguese flavour. The company is still a family business and Mr. G. A. Morgan, a son of the founder, presides over its destinies as managing director.

THE FIRM OF Schneider et Cie shows for the financial year ended with April 30 last net profits of 25,473,819 fcs., after an allotment to the sinking fund, inclusive of the sum brought forward from the previous year. A dividend of 100 fcs. per share will be distributed, absorbing 25,000,000 fcs.

A REDUCTION OF THE CAPITAL of Messrs. S. H. Heywood & Company, Limited, electrical, hydraulic and general engineers, of Reddish, from £50,000 to £34,000, has been sanctioned by the Manchester Chancery Court. It is proposed to return 10s. per share to the holders of the preference shares.

Heat-Resisting Steels.

In a communication from the Research Institute of the United Steelworks Company, published in a recent issue of "Archiv für das Eisenhüttenwesen" as Report No. 189 of the Working Materials Committee of the German Ironmasters' Association, E. SCHEIL and E. H. SCHULZ gave the results of tests on low-carbon steels containing up to 18 per cent. Cr and 14 per cent. Al. These steels, 25 in number, were examined with regard to resistance to scaling at temperatures up to 1,200 deg. C., resistance to attack by dilute acids and for electrical conductivity up to 1,000 deg. C.

The scale produced with the various alloys differs in appearance and also under examination by X-rays. Three ranges can be distinguished:—(1) That with the white alumina scale includes the steels of the greatest heat resistance; then follows (2) the range with the chromium-oxide scale, which lies at the border of the compositions investigated and which, with higher chromium contents, probably gives steels also very resistant to scaling; and (3) the range with iron-oxide scale, of which the resistance to scaling is inadequate. The alumina scale which forms on the steel is permanent if the surface of the steel is still within the scale-resistant range after the reduction in the content of aluminium due to oxidation.

Resistance to scaling and to acid attack do not run parallel in the chromium-aluminium steels examined. The heat-resisting qualities improve with increasing aluminium content; on the other hand, the resistance to acids is reduced.

Both aluminium and chromium raise the electrical resistance of the steels, the effect being appreciably greater at low than at high temperatures. High additions of chromium lower the temperature coefficient of the resistance.

Pease & Partners, Limited.

PERMANENT REORGANISATION SCHEME.

A permanent reorganisation scheme is now put forward by the directors of Pease & Partners, Limited, with the co-operation of the advisory committee. This committee was appointed on September 30 to supervise and control the working of the moratorium scheme which was sanctioned by the Court in 1931. The committee now consider that the moratorium has served its purpose, and have advised the company that unless the whole financial structure is reorganised on lines which, if trade revives, should afford a permanent solution of the company's difficulties, they must exercise their right to bring the moratorium to an end with its attendant consequences of receivership or liquidation.

As in the case of the first scheme, the 4 per cent. debenture stock, amounting to £400,000, which is irredeemable and carries a first floating charge on the undertaking, is not affected, and interest will continue to be paid. The scheme provides for the passing of the large majority of the issued shares into the hands of the creditors. It provides for the writing down of the share capital by one-half to £1,500,000 and for the surrender to the company of £1,350,000 of this reduced amount for distribution among holders of the loan capital and creditors. Payment of interest unpaid on the 5 per cent. stock is waived and further interest is not payable until 1938. The scheme makes provision for raising further working capital as and when required by the issue of a further £100,000 Thorne Colliery debentures in addition to the amount already authorised, and at the same time the company is empowered to create and issue, with the consent of the Treasury, £250,000 prior lien bonds secured by specific charges or mortgages of the freehold and leasehold properties of the company other than the Thorne Colliery and by a second floating charge. The scheme is strongly recommended by the advisory committee.

THE BRITON FERRY STEELWORKS, at Llanelly, restarted two of its six furnaces on Monday, after a long period of idleness.

This Week's News in Brief.

Trade Talk.

Walter Scott, Limited (Leeds Steel Works), Leeds, announce that they are making arrangements to restart a blast furnace and will shortly be in a position to supply their usual grades of pig-iron.

The members of the Glasgow and West of Scotland Association of Foreman Engineers and Draughtsmen have accepted an invitation to visit the foundry and works of Messrs. D. & J. Tullis, Limited, Kilbowie Iron Works, Clydebank, next Saturday.

Mr. Stanley Brooks, who has been representing in the Manchester area the General Refractories, Limited, of Sheffield, is joining the Manchester office staff of Stanton Ironworks Company, Limited. Mr. Brooks will be employed assisting with pig-iron sales.

The annual social meeting of the staff and workers of Messrs. R. Taylor & Company, Muirhall Foundry, Larbert, took place on November 18. Mr. George Ure presided after tea, when a variety and musical programme was carried through, followed by a dance.

The workshops of Messrs. David M. Tyre & Company, architectural smiths and art metal workers, of Blackfaulds Place, Glasgow, were seriously damaged by a fire on November 18. Temporary premises have been obtained nearby in which business is being carried on.

The employees of the Blantyre Engineering Company, Limited, Hamilton, held their annual dance in the "Salon," Hamilton, on November 18, when a most happy time was spent. Among those present were Mr. Robert Kelly and Mr. Clement Rodgerson, directors, and the works officials.

Messrs. Stewarts & Lloyds, Limited, have generously placed the old Caledonian Tube Works, in Main Street, Coatbridge, at the service of the Coatbridge Mutual Service Club for unemployed. The premises have been reconditioned and arranged for various forms of recreation and industry. The club at the same time received an anonymous gift of £250.

Messrs. James Noble, Fraserburgh, have launched a motor-boat, the "Alban," built to the order of Mr. Robert Galbraith, Carradale, Argyle. The vessel is fitted with Kelvin Diesel crude-oil engines. There is an electric-lighting installation throughout, with searchlight. It is equipped with a special large fish-hold and will be engaged in ring-net fishing on the West Coast.

A casting, comprising 94 tons of metal, was cast at the Newhall works of the Brightside Foundry & Engineering Company, Limited, Sheffield, on Friday last. The molten metal was poured into a mould approximately 9 ft. 6 in. square by 7 ft. deep. The finished product will be an anvil block for an 80-cwt. drop stamp, and will weigh 86 tons, the amount of metal melted being 104 tons. The mould took three men four weeks to make, and was filled by the metal in nine minutes. The order was placed by a Lincoln firm.

Messrs. Saunders & Connor (Barrhead), Limited, Darnley Works, Barrhead, were fined £10 and expenses in Paisley Sheriff Court when they were prosecuted under the Factory and Workshop Act for neglect to observe regulations in respect that conductors, viz., cables carrying electric current to an overhead crane in the bath-moulding department, were not so worked as to prevent danger as far as was reasonably practicable while a workman was preparing to erect a staging, and in consequence of his coming in contact with the conductors he was electrocuted.

The Tata Iron & Steel Company will produce galvanised sheets early next year. The erection of the mill has been considerably anticipated by the hustle of the company's American engineers. It is now so far advanced that it will be a record for the construction of such a plant. The bar-rolling mill will be altered on arrival of the special 7,500-h.p. British Thomson-Houston motor, already shipped from Tilbury well within scheduled time. The "Taylor" patent pickling and washing unit (the only sheet mill plant ordered in this country) has already been shipped from Swansea well before delivery date.

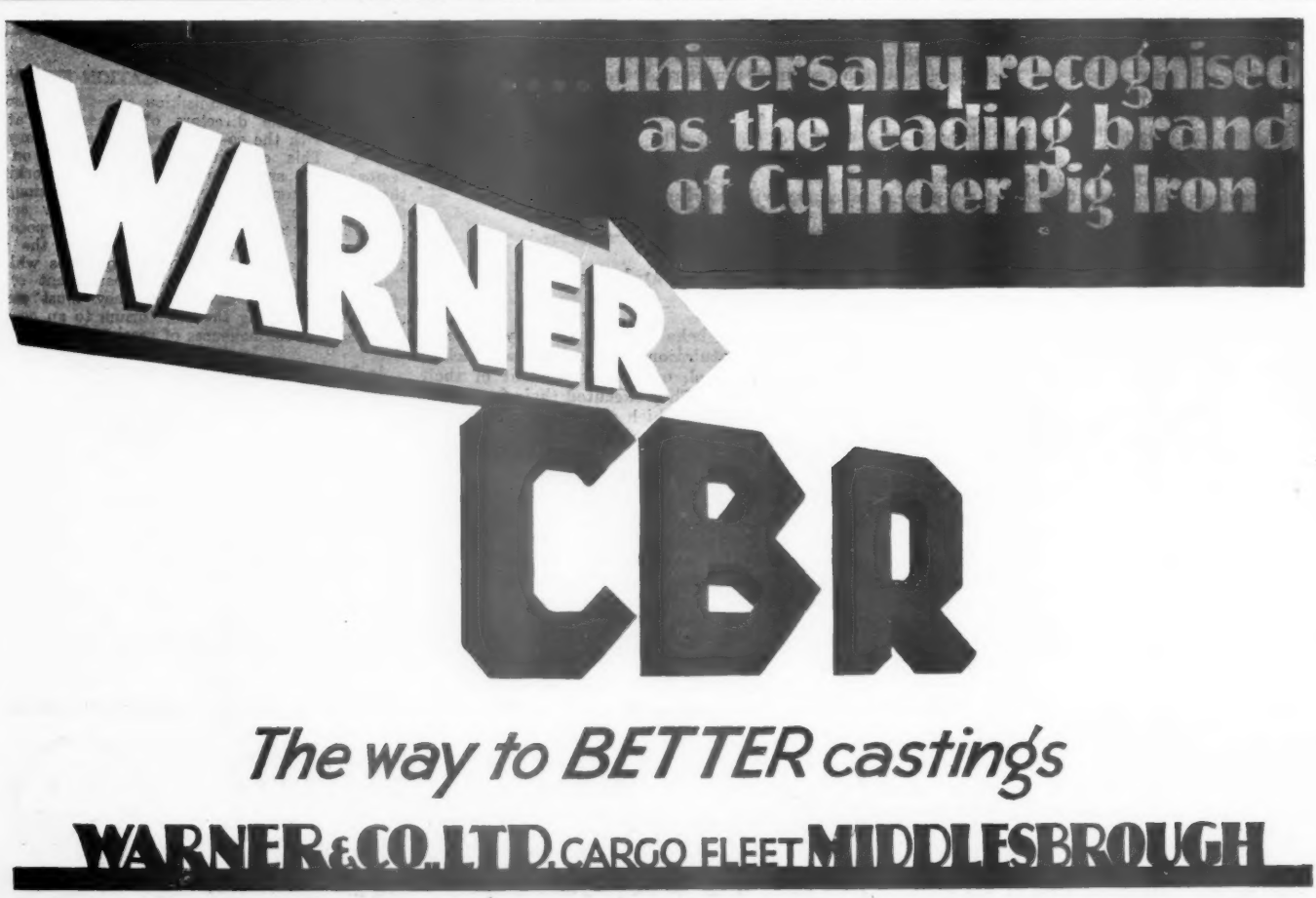
Obituary.

Mr. George Reynolds Austin, one of the founders of the firm of Austin, McGillivray & Company, Limited, steel manufacturers, Napier Street, Sheffield, has died at the age of 68.

Mr. Bernard Edward Cammell, last surviving son of the late Mr. Charles Cammell, founder of the firm of Cammell, Laird & Company, Limited, has died at Guildford, aged 82. The firm was founded as Charles Cammell & Company, Limited, and for a short time Mr. Bernard Edward Cammell took part in its management at Dronfield.

Mr. Walter Carter, a director of Messrs. J. J. Saville & Company, Limited, Triumph Steelworks, Sheffield, and sales manager for the company in Great Britain, died on Saturday, November 19, at the age of 58. Mr. Carter had a wide knowledge of the application and treatment of alloy steels of all kinds, particularly high-speed steels. Before going to Sheffield, about 25 years ago, to join J. J. Saville & Company, he had spent about ten years with Sir W. G. Armstrong, Whitworth & Company, Limited, at Openshaw.

The death occurred, in an Edinburgh nursing home, on November 19, of Mr. George Dobbie, of Messrs. Dobbie Forbes & Company, Limited, Larbert Foundry, Larbert. Mr. Dobbie had been in his usual health up to about three weeks ago, and was making good progress towards recovery from an illness which developed somewhat unexpectedly when a relapse set in on November 18, and he passed away early the following day. The deceased gentleman was a native of the Camelon district of Falkirk; he served his apprenticeship as a pattern-maker and became connected with Larbert Foundry about 60 years ago, as departmental manager. He afterwards became works manager, and a year or two prior to the death of Major Dobbie, in 1908, he was, with Mr. Cameron Walker, taken into partnership. Chiefly concerned with the productive side of the firm's activities, his administrative duties brought him into close touch with the workers, with whom he was always on the most friendly terms, and he was highly esteemed in every department. Mr. Dobbie was in his 80th year and is survived by Mrs. Dobbie, one daughter and four sons.



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Raw Material Markets.

Business continues to move more freely in the iron and steel markets, but the demand as yet is not sufficient to justify the restarting of idle plant. The general demand for material from the shipbuilding and heavy engineering industries has shown little improvement. Little Continental material is coming into this country, whilst British exports are showing a slight improvement, in spite of exchange and tariff difficulties. It is too early as yet for the Ottawa tariff changes seriously to affect the situation, but it is expected that increased business will be done with Empire consumers in the New Year.

Pig-Iron.

MIDDLESBROUGH.—The position is now slightly improved in the Cleveland market. Better conditions in the consuming industries have resulted in an increase in the number of forward contracts booked. The fact that there are now only three blast furnaces producing Cleveland iron, and that stocks are being extensively drawn upon, is also tending to convince consumers of the necessity of assuring supplies over the coming months. The full official rates are quoted and these are unchanged, as follow :—No. 1 Cleveland foundry iron, 61s. per ton; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge iron, 57s. per ton.

The demand for East Coast hematite is reported to be gradually increasing, but owing to the increased output and the heavy stocks of unsold material, producers can make no increase in the present quotations, which are generally agreed to be at a very low level. Prices are, however, maintained at 59s. per ton for mixed numbers, with 6d. premium for No. 1 quality. One or two merchants have been able to cut below these levels, and have thus negotiated a few small export sales.

LANCASHIRE.—Sales of pig-iron are gradually increasing, though business is largely confined to small parcels for early delivery, foundries still being chary of entering into long-term contracts. Larger deliveries are being called for by the heavy electrical industry, and better reports are forthcoming from one or two jobbing foundries. Prices are maintained, current offers of Staffordshire and Derbyshire No. 3 being on the basis of 67s. per ton for delivery in the Manchester area, with Cleveland at about the same figure, Northamptonshire at 65s. 6d., Derbyshire forge at 62s., Scottish foundry at around 83s. and West Coast hematite at about 81s. per ton.

MIDLANDS.—Deliveries of pig-iron into consumption continue to show improvement over last month's level, and there is more inclination to enter into forward contracts. Quotations remain at 62s. 6d. per ton for Northants No. 3 and 66s. for North Staffordshire, Derbyshire and Lincolnshire No. 3, including delivery to Birmingham and Black Country stations. Cleveland No. 3 is unchanged at 66s. Continental iron remains uncompetitive.

SCOTLAND.—Owing to the irregularity of work at the foundries, the demand for pig-iron is still disappointing. Many of the works connected with the shipbuilding and heavy-engineering industries remain closed, and the outlook for the coming year is not very good. No. 3 Scottish foundry is at 67s. 6d. per ton at furnaces, with 2s. 6d. extra for No. 1 quality. No. 3 Middlesbrough is obtainable at 55s., f.o.t Falkirk, with other English irons at about 1s. less.

Coke.

The demand for coke has shown little improvement. Few consumers are entering into contracts extending over the next month or two, as is the usual custom at this season of the year. In the absence of buying, prices are unaltered at 30s. to 45s. for Welsh foundry coke, with best Durhams at about 36s. 6d. to 38s. per ton, delivered Midland stations.

Steel.

There has been a partial lull in trading, generally attributed to uncertainties arising from the debt repayment discussions and fears of their effect upon international trade. There has also been a diminution in the volume of inquiry, and the markets at home and overseas appear to be marking time. In the semi-finished steel department, trading has become quieter, but most of the business transacted has gone to the British works. Continental prices have shown signs of weakness, but this has not stimulated business. In the finished-steel section of the market, similar conditions prevail and business appears to have relapsed into a state of apathy, both buyers and sellers awaiting developments. There has been a noticeable falling-off in the amount of business transacted in foreign steel for export. Some inquiry is reported from overseas markets, but little of this has resulted in business. In the home market the general note is one of uncertainty and buyers appear to be following a cautious policy.

Scrap.

The demand has improved in the Cleveland scrap-iron market, machinery material, which is very scarce, being bought at up to 40s. per ton, with ordinary heavy grades at 37s. 6d. There is a steady demand from the foundries in the Midlands and prices are firm. In South Wales, heavy cast iron is firmer at 40s. to 41s., with machinery scrap at 45s. to 47s. 6d. In Scotland supplies of scrap are plentiful, machinery quality being unchanged at 44s., with ordinary cast iron at 38s. 6d. to 39s. per ton.

Metals.

Copper.—The demand from consumers remains poor, but sterling prices have remained fairly steady, owing to the weakness of the exchange. The outcome of the copper producers' conference is being anxiously awaited in trade circles. If the Empire mines agree to a curtailment of output it is doubted whether, in that case, their production would be sufficient to supply the needs of the Empire, as assumed under the Ottawa agreements, by which a duty is imposed on imports of foreign metal. Hence, the course of the market is likely to be uncertain in the near future.

Closing quotations :—

Cash.—Thursday, £31 17s. 6d. to £32; Friday, £32 7s. 6d. to £32 8s. 9d.; Monday, £32 5s. to £32 7s. 6d.; Tuesday, £32 2s. 6d. to £32 5s.; Wednesday, £32 3s. 9d. to £32 5s.

Three Months.—Thursday, £32 5s. to £32 7s. 6d.; Friday, £32 15s. to £32 16s. 3d.; Monday, £32 12s. 6d. to £32 13s. 9d.; Tuesday, £32 10s. to £32 11s. 3d.; Wednesday, £32 11s. 3d. to £32 12s. 6d.

Tin.—There is a fair demand from South Wales for this metal, but otherwise the demand from consumers has fallen away. Consumers on the Continent and in the United States also report a slight slackening of activity. The immediate outlook is not very encouraging.

Official closing prices :—

Cash.—Thursday, £151 17s. 6d. to £152 2s. 6d.; Friday, £152 to £152 5s.; Monday, £151 7s. 6d. to £151 10s.; Tuesday, £150 10s. to £150 15s.; Wednesday, £151 15s. to £151 17s. 6d.

Three Months.—Thursday, £153 to £153 5s.; Friday, £153 7s. 6d to £153 10s.; Monday, £152 17s. 6d. to £153; Tuesday, £151 15s. to £152; Wednesday, £153 to £153 5s.

Spelter.—Consumers in Europe are making only a moderate demand on the market. Supplies, however, are under firm control, and it is expected that the output restriction measures now in force will result in further reductions in world stocks. The present political and trade uncertainty, however, tends to dissuade users from buying anything but supplies for immediate use.

Daily fluctuations :—

Ordinary.—Thursday, £15 1s. 3d.; Friday, £15 1s. 3d.; Monday, £15; Tuesday, £14 17s. 6d.; Wednesday, £15 2s. 6d.

Lead.—Prices have been slightly disorganised by the movements of the exchange, etc., and interest in the market at the moment is mainly professional. It is believed that consumption in this country has fallen away recently, but, owing to international restriction of supplies, the fundamental position of this metal remains fairly sound.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £11 12s. 6d.; Friday, £11 13s. 9d.; Monday, £11 13s. 9d.; Tuesday, £11 13s. 9d.; Wednesday, £12 1s. 3d.

Personal.

Mr. A. W Kieft has been elected to the board of Messrs. Richard Thomas & Company, Limited, to fill the vacancy caused by the death of Mr. J. Brynmor Hill.

The telephone number at Mr. Vincent C. Faulkner's home address, 70, Carlton Avenue, Kenton, Middlesex, has been changed from Harrow 0845 to Wordsworth 1073.

Mr. H. G. Sommerfield, the chairman of the London Section of the Institute of British Foundrymen, has been elected to the Common Council for the Aldersgate Ward of the City of London.

Mr. Gerald Steel, a son of the late Mr. Harry Steel, founder and first chairman of the United Steel Companies, Limited, has been appointed general manager of Messrs. Samuel Fox & Company, Limited, in succession to Mr. F. S. Scott Smith, who is retiring after 38 years' service.

New Companies.

United Lead & Zinc Mining Corporation, Limited, 11, Queen Victoria Street, London, E.C.4.—Capital £1,000.

National Alloys, Limited.—Capital £5,000. Solicitors: Linklaters & Paines, 2, Bond Court, Walbrook, London, E.C.4.

Improved Metallurgy, Limited.—Capital £50,000. Solicitors: Linklaters & Paines, 2, Bond Court, Walbrook, London, E.C.4.

William Whiteley & Sons, Limited, Prospect Ironworks, Lockwood, Huddersfield.—Capital £100. Engineers. Directors: J. and H. Charlesworth.

A. C. F. Bars, Limited, 26-30, Holborn Viaduct, London, E.C.—Capital £2,000. Ironfounders, etc. Directors: F. C. Neuberger, G. Rosenmann and S. Grunberg.

Smith, Wallis & Company, Limited, Highgate Works, Milk Street, Birmingham.—Capital £3,000. General founders. Directors: H. B., Marion L. and C. Wallis.

Clarke & Matthes, Limited.—Capital £1,000. Machine and machine-tool manufacturers. Solicitors: Cruesemann & Rouse, 41-2, King William Street, London, E.C.

Metallisation, Limited.—Capital £60,000. Metal surfacing. Directors: C. H. Barwell, Holmewood, Park Hill, Kenilworth; Sir Martin J. Melvin, A. H. Wellesley, E. H. M. White, W. E. Ballard and A. S. Hollings.

Company Reports.

Associated Fireclay Companies, Limited.—The directors have decided to pass the interim dividend on the ordinary shares.

Hepworth & Grandage, Limited.—Net profit, £18,239; brought in, £2,368; dividend of 10 per cent.; to reserve, £5,000; carried forward, £3,106.

United Steel Companies, Limited.—Trading profit, before providing for depreciation, £330,288; balance, after deducting interest on fixed loan and mortgages, income tax, etc., £187,353; brought in, £116,588; to reserve for depreciation, £175,000; carried forward, £128,941.

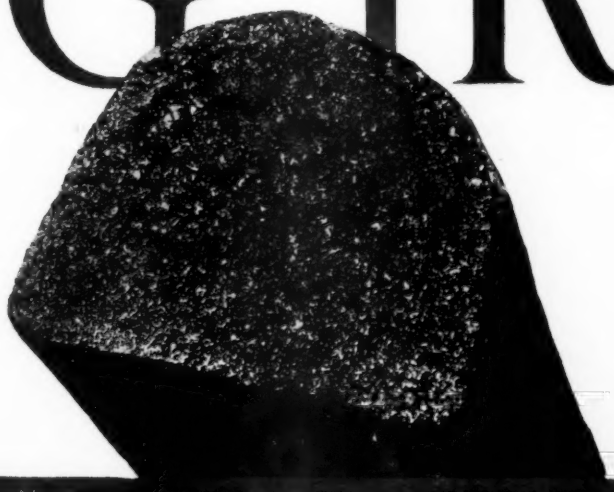
Richard Thomas & Company, Limited.—Gross profit for the six months ended March 31, £105,147; interest on debentures, loans and other charges, £60,044; provision for depreciation and special expenditure, £32,500; net profit, £8,710; brought in, £213,422; carried forward, £222,133.

Weardale Lead Company, Limited.—Loss for year of £1,540, increasing the debit balance to £10,002. The reserve fund of £14,582 has been applied in extinguishing the whole of this debit balance and in writing down the investments to a figure more nearly corresponding to their market value.

John Whyte, slag breaker at Messrs. Colvilles, Limited, Dalzell Steelworks, Motherwell, met with a serious accident which necessitated his removal to the Glasgow Royal Infirmary. He was engaged shunting two wagons of slag pots, and after the wagons had been coupled off, one of the crane hooks caught in a lug of the slag pot, pulling it off the wagon. The pot fell upon Whyte and severely crushed him.

XUM

PIG IRON



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WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	32	3	9
Three months	32	11	3
Electrolytic	37	0	0
Tough	34	5	0
Best selected	34	15	0
Sheets	65	0	0
India	46	0	0
Wire bars	37	10	0
Do., Jan.	37	10	0
Do., Feb.	37	10	0
Ingot bars	37	10	0
H.C. wire rods	40	0	0
Off. av. cash, October	31	18	7 13/16
Do., 3 mths., October	32	1	8 5/7
Do., Sttlmnt., October	31	18	8 3/7
Do., Electro, October	36	10	11 3/7
Do., B.S., October	34	15	0
Do., wire bars, October	36	18	1 1/7
Solid drawn tubes			10d.
Brazed tubes			10½d.
Wire			7d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8½d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	8d.
Wire	7½d.
Rolled metal	7½d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN.

	£	s.	d.
Standard cash	151	15	0
Three months	153	0	0
English	152	10	0
Bars	154	10	0
Straits	156	0	0
Australian	154	10	0
Eastern	156	15	0
Banca	157	10	0
Off. av. cash, October	151	7	6
Do., 3 mths., October	152	4	10½
Do., Sttlmt., October	151	7	7½

SPELTER.

	£	s.	d.
Ordinary	15	2	6
Remelted	14	10	0
Hard	12	15	0
Electro 99.9	17	5	0
English	15	17	6
India	14	0	0
Zinc dust	22	0	0
Zinc ashes	2	10	0
Off. aver., October	15	0	1 1/16
Aver. spot, October	14	17	4 3/7

LEAD.

	£	s.	d.
Soft foreign ppt.	12	1	3
Empire	12	0	0
English	13	10	0
Off. average, October	12	1	3 5/16
Average spot, October	11	19	2

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	10	0
Do., V.M. ex-whse.	24	0	0
Rods	27	0	0
Boiler plates	23	0	0
Battery plates		—	

ANTIMONY.

	£	s.	d.	£	s.	d.
English	37	10	0 to	42	10	0
Chinese				27	0	0
Crude				19	10	0

QUICKSILVER.

	£	s.	d.
Quicksilver	10	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£8 0 0
45/50%	£13 15 0
75%	£19 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	10d. lb.
Ferro-phosphorus, 20/25%	£20 0 0
Ferro-tungsten—	
80/85%	1/7½ lb.
Tungsten metal powder—	
98/99%	1/10½ lb.
Ferro-chrome—	
2/4% car.	£32 17 6
4/6% car.	£25 0 0
6/8% car.	£24 2 6
8/10% car.	£23 5 0
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car.	£40 2 6
Max. 0.70% car.	£43 12 6
70% carbon-free	1/- lb.
Nickel—80/99.5%	£260 to £265
"F" nickel shot	£234 0 0
Ferro-cobalt	7/9 lb.
Aluminium 98/99%	£100 0 0
Metallic chromium—	
96/98%	2/9 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	1	18	6 to	2	0	0
Bundled steel and shrngs.	1	15	0 to	1	19	0
Mixed iron and steel	1	12	6 to	1	16	0
Heavy cast iron	2	0	0 to	2	1	0
Good machinery	2	5	0 to	2	7	6
Cleveland—						
Heavy steel				1	17	6
Steel turnings				1	7	6
Cast-iron borings				1	2	6
Heavy forge				2	10	0
W.I. piling scrap				2	2	6
Cast-iron scrap	1	17	6 to	2	0	0
Midlands—						
Light cast-iron scrap				1	15	6
Heavy wrought iron				2	5	0
Steel turnings, f.o.r.				1	0	0
Scotland—						
Heavy steel				1	15	0
Ordinary cast iron				1	18	6
Engineers' turnings				1	8	6
Cast-iron borings				1	10	0
Wrought-iron piling				1	18	6
Heavy machinery				2	4	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	24	0	0
Brass	16	0	0
Lead (less usual draft)	10	10	0
Tea lead	9	0	0
Zinc	8	10	0
New aluminium cuttings	72	0	0
Braziery copper	21	0	0
Gunmetal	20	0	0
Hollow pewter	82	0	0
Shaped black pewter	65	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
,, at Falkirk	55/-
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	59/6
Hematite M/Nos.	59/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	69/-
,, d/d Birm.	84/6
Malleable iron d/d Birm.	117/6
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	61/-
,, No. 3 fdry.	66/-
Northants forge	57/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	61/-
fdry. No. 3	66/-
,, fdry. No. 1	69/-
,, basic	—
Scotland—	
Foundry No. 1	70/-
,, No. 3	67/6
Hem. M/Nos. d/d	67/6
Sheffield (d/d district)—	
Derby forge	58/6
,, fdry. No. 3	63/6
Lincs forge	—
,, fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
,, fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	83/-
Clyde, No. 3	83/-
Monkland, No. 3	83/-
Summerlee, No. 3	83/-
Eglinton, No. 3	83/-
Gartsherrie, No. 3	83/-
Shotts, No. 3	83/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	0	0 to	9	15	0
Nut and bolt iron	7	15	0 to	8	0	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ½ in. × 4 in.				12	5	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	8	7	6 to	9	5	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ½ in. (Untested)			6 15 0 & up.			
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)	9	10	0 to	10	10	0
Black sheets, 24g. (10-t. lots)				9	5	0
Galv. cor. shts. ,,				11	5	0
Galv. flat shts. ,,				11	15	0
Galv. fencing wire, 8g. plain				14	0	0
Billets, soft	4	17	6 to	5	7	6
Billets, hard	6	12	6 to	7	2	6
Sheet bars	4	15	0 to	5	2	6
Tin bars				4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	11½d.
Rods	10½d.
Tubes	16½d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	13.59
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.39
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	37.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.10
Sheets, galv., No. 24	2.85
Wire nails	1.95
Plain wire	2.20
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	20/- to 22/6
,, furnace	16/- to 16/6
Durham and Northumberland—	
,, foundry	21/- to 25/-
,, furnace	12/- to 12/6
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	15/9 to 16/3
,,	28×20 ,,	31/6 to 32/6
,,	20×10 ,,	22/7½ to 23/-
,,	18½×14 ,,	16/4½ to 16/7½
C.W.	20×14 ,,	13/9 to 14/3
,,	28×20 ,,	—
,,	20×10 ,,	—
,,	18½×14 ,,	—

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0	to	£7 0 0
Bars-hammered, basis	£16 10 0	to	£17 0 0
Bars and nail-rods, rolled, basis	£15 17 6	to	£16 5 0
Blooms	£10 0 0	to	£12 0 0
Keg steel	£32 0 0	to	£33 0 0
Faggot steel	£18 0 0	to	£23 0 0
Bars and rods dead soft, st'l	£10 0 0	to	£12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£ s. d.	
Nov.	24 ..	31 17 6	dec. 1/3
,,	25 ..	32 7 6	inc. 10/–
,,	28 ..	32 5 0	dec. 2/6
,,	29 ..	32 2 6	,, 2/6
,,	30 ..	32 3 9	inc. 1/3

Electrolytic Copper.

		£ s. d.	
Nov.	24 ..	36 5 0	No change
,,	25 ..	37 0 0	inc. 15/–
,,	28 ..	37 0 0	No change
,,	29 ..	37 0 0	,, ,,
,,	30 ..	37 0 0	,, ,,

Standard Tin (cash).

		£ s. d.	
Nov.	24 ..	151 17 6	dec. 15/–
,,	25 ..	152 0 0	inc. 2/6
,,	28 ..	151 7 6	dec. 12/6
,,	29 ..	150 10 0	,, 17/6
,,	30 ..	151 15 0	inc. 25/–

Tin (English ingots).

		£ s. d.	
Nov.	24 ..	152 10 0	dec. 15/–
,,	25 ..	152 15 0	inc. 5/–
,,	28 ..	152 0 0	dec. 15/–
,,	29 ..	151 5 0	,, 15/–
,,	30 ..	152 10 0	inc. 25/–

Spelter (ordinary).

		£ s. d.	
Nov.	24 ..	15 1 3	dec. 5/–
,,	25 ..	15 1 3	No change
,,	28 ..	15 0 0	dec. 1/3
,,	29 ..	14 17 6	,, 2/6
,,	30 ..	15 2 6	inc. 5/–

Spelter (Electro, 99.9 per cent.).

		£ s. d.	
Nov.	24 ..	17 10 0	dec. 2/6
,,	25 ..	17 5 0	,, 5/–
,,	28 ..	17 5 0	No change
,,	29 ..	17 5 0	,, ,,
,,	30 ..	17 5 0	,, ,,

Zinc Sheets (English).

		£ s. d.	
Nov.	24 ..	24 10 0	No change
,,	25 ..	24 10 0	,, ,,
,,	28 ..	24 10 0	,, ,,
,,	29 ..	24 10 0	,, ,,
,,	30 ..	24 10 0	,, ,,

Lead (English).

		£ s. d.	
Nov.	24 ..	13 5 0	No change
,,	25 ..	13 5 0	,, ,,
,,	28 ..	13 5 0	,, ,,
,,	29 ..	13 5 0	,, ,,
,,	30 ..	13 10 0	inc. 5/–

AVERAGE MONTHLY PRICES OF CLEVELAND No. 3 PIG-IRON.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1892	37 7	35 7	36 10	37 10	39 2	40 11	39 11	39 10	40 0	38 6	37 6	37 4	38 5
1893	36 0	34 5	34 4	34 2	33 10	34 8	35 3	35 5	35 4	34 8	34 7	35 9	34 10
1894	35 8	35 11	36 1	36 1	35 5	35 5	35 5	35 11	36 6	35 8	35 8	35 1	35 9
1895	34 7	34 4	34 4	34 8	35 6	35 2	36 1	37 1	38 10	38 6	37 11	37 6	36 3
1896	37 3	38 4	38 7	38 1	37 4	37 4	36 11	36 11	37 11	39 2	40 5	40 5	38 3
1897	41 2	40 4	40 5	39 2	39 7	40 9	39 6	40 5	41 7	42 5	41 5	40 4	40 7
1898	40 0	40 8	40 6	40 0	40 7	39 11	40 4	41 11	43 0	44 11	49 1	44 3	42 0
1899	46 10	47 11	47 9	49 10	55 11	62 10	71 6	65 9	67 7	68 8	70 0	66 9	60 5
1900	67 10	68 10	73 10	76 2	74 2	68 6	69 3	71 4	70 9	67 8	63 6	53 6	68 9
1901	48 0	46 6	45 8	45 5	45 10	44 7	44 6	45 3	45 3	45 3	43 6	43 1	45 3
1902	48 11	46 7	46 9	47 11	48 10	49 7	50 9	52 1	53 6	52 9	50 9	47 11	49 3
1903	47 3	48 9	51 10	49 0	46 1	46 2	46 7	46 8	45 7	43 6	42 10	41 11	46 4
1904	42 3	42 7	43 3	44 7	44 0	42 10	42 9	43 3	43 1	43 9	46 1	48 7	43 11
1905	48 11	48 0	49 6	50 1	51 5	45 6	45 9	47 5	48 8	52 11	52 9	53 3	49 6
1906	53 9	50 1	48 1	48 8	50 2	50 3	50 6	53 0	54 6	56 8	58 6	62 4	53 6
1907	60 4	56 6	54 10	56 0	61 1	58 1	57 8	57 8	55 7	54 8	50 8	50 0	56 2
1908	48 5	49 3	51 7	51 10	51 6	51 2	50 0	51 4	52 0	49 8	49 4	48 11	50 8
1909	48 10	48 1	46 9	47 9	48 4	48 9	48 6	50 5	51 3	51 11	51 2	50 7	49 4
1910	51 10	51 3½	51 7½	50 10	49 10	49 2	48 10	49 8½	49 3½	49 7½	49 6½	49 10	50 4
1911	49 11½	49 2½	48 5	46 11	46 4	46 6	46 11½	47 4	47 0	46 7	47 4½	48 1	47 7
1912	50 0	49 5½	51 1½	53 7½	54 4	55 1	57 5½	64 6½	61 7½	66 8½	67 8	68 0	58 5½
1913	66 11½	63 8½	64 8	67 1½	66 3	56 9½	56 3½	55 8	55 4	53 0	50 1	50 4	58 10
1914	50 11	51 5½	51 0½	51 4½	51 6	51 6½	51 5	52 3	51 5	50 1	50 3	53 0	51 4½
1915	55 7	56 6	61 0	66 7	65 2	66 10	65 4	66 0½	65 3	65 11	69 10½	75 7½	65 7
1916	80 2	91 6	87 4½	86 10	82 6	82 6	87 6	87 6	87 6	87 6	87 6	87 6	85 10
1917	87 6	87 6	87 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	92 6	95 0	99 3
1918	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0	95 0
1919	95 0	95 0	95 0	95 0	152 6	160 0	160 0	160 0	160 0	160 0	160 0	160 0	137 8
1920	175 0	175 0	187 6	200 0	208 0	217 6	217 6	221 0	225 0	225 0	225 0	225 0	209 3
1921	222 6	195 0	150 0	126 0	120 0	120 0	120 0	136 3	127 0	120 0	110 0	100 0	137 4
1922	92 6	90 0	90 0	90 0	90 0	90 0	89 0	87 3	92 6	92 6	92 6	91 3½	90 7½
1923	94 6	108 9	125 6	129 4½	128 5	136 0	128 1½	121 11	97 1½	97 0	100 0	100 0	110 6½
1924	99 10	97 3½	91 9	93 9	91 9	89 10½	87 9	85 0	82 5½	80 2½	81 9	81 9	88 7½
1925	80 4½	78 10½	78 0	78 3	76 0	73 10½	71 7½	69 10½	68 1½	66 7½	66 0	66 10½	72 10½
1926	69 4½	70 0	70 0	70 0	72 6	75 10½	86 7½	90 0	93 10½	117 10	120 0	99 0	86 3
1927	85 0	83 1½	81 0	80 0	73 9	70 0	70 0	68 9	67 6	67 6	66 10½	65 0	73 2½
1928	65 0	65 0	65 6	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	65 9½
1929	66 0	66 9	67 0	68 1½	69 5	71 10½	72 9	72 6	72 6	72 6	72 6	72 6	70 4½
1930	72 6	72 6	70 0	67 6	67 6	67 6	67 6	64 6	63 6	63 6	63 6	63 6	66 11½
1931	59 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 7
1932	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	58 6	—	—

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COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

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TILGHMAN Sand Blast Room, 12 ft. x 9 ft., complete with Air Compressor.

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TILGHMAN DOUBLE BARREL Rotary Sand Blast, barrels 24 in. x 20 in., complete with Air Compressor.

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